PALÆONTOGRAPHICAL SOCIETY.

VOL. XLVII.

FOSSIL SPONGES.

PART III.

PAGES 189—254; PLATES X—XIX.

CRETACEOUS ECHINODERMATA.

VOL. II, PART II.

(ASTEROIDEA.)

PAGES 29—66; PLATES IX—XVI.

INFERIOR OOLITE AMMONITES.

PART VIII.

PAGES 345—376; PLATES LXXVII—XCII.

DEVONIAN FAUNA OF THE SOUTH OF ENGLAND.

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PAGES 89—160; PLATES XI—XVII.

ISSUED FOR 1893.

California Academy of Sciences

Presented by Paleontographical Society.

December, 1906.

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AND

I. A CATALOGUE OF THE WORKS ALREADY PUBLISHED;

II. A CLASSIFIED LIST OF THE MONOGRAPHS COMPLETED, IN COURSE OF PUBLICATION, AND IN PREPARATION, WITH THE NAMES OF THEIR RESPECTIVE AUTHORS;

III. THE DATES OF ISSUE OF THE ANNUAL VOLUMES;

IV. A GENERAL SUMMARY, SHOWING THE NUMBER OF THE PAGES, PLATES, FIGURES, AND SPECIES IN EACH MONOGRAPH;

V. A STRATIGRAPHICAL LIST OF THE BRITISH FOSSILS FIGURED AND DESCRIBED IN THE YEARLY VOLUMES.

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Showing the ORDER *of publication; the* YEARS *during which the Society has been in operation; and the* CONTENTS *of each yearly Volume.*

Vol. I.	Issued for the Year	1847	The Crag Mollusca, Part I, Univalves, by Mr. S. V. Wood, 21 plates.
„ II.	„	1848	The Reptilia of the London Clay, Vol. I, Part I, Chelonia, &c., by Profs. Owen and Bell, 38 plates. The Eocene Mollusca, Part I, Cephalopoda, by Mr. F. E. Edwards, 9 plates.
„ III.*	„	1849	The Entomostraca of the Cretaceous Formations, by Mr. T. R. Jones, 7 plates. The Permian Fossils, by Prof. Wm. King, 29 plates. The Reptilia of the London Clay, Vol. I, Part II, Crocodilia and Ophidia, &c., by Prof. Owen, 18 plates. The Fossil Corals, Part I, Crag, London Clay, Cretaceous, by Messrs. Milne Edwards and Jules Haime, 11 plates.
„ IV.	„	1850	The Crag Mollusca, Part II, No. 1, by Mr. S. V. Wood, 12 plates. The Mollusca of the Great Oolite, Part I, Univalves, by Messrs. Morris and Lycett, 15 plates. The Fossil Brachiopoda, Vol. I, Part III, No. 1, Oolitic and Liassic, by Mr. Davidson, 13 plates.

* The Volume for the year 1849 consists of two separate portions, each of which is stitched in a paper cover, on which are printed the dates 1848, 1849, and 1850. The one portion contains 'Cretaceous Entomostraca' and 'Permian Fossils;' the other, 'London Clay Reptilia,' Part II, and 'Fossil Corals,' Part I.

CATALOGUE OF WORKS—Continued.

Vol. V.	Issued for the Year 1851		The Reptilia of the Cretaceous Formations, by Prof. Owen, 39 plates. The Fossil Corals, Part II, Oolitic, by Messrs. Milne Edwards and Jules Haime, 19 plates. The Fossil Lepadidæ, by Mr. Charles Darwin, 5 plates.
„ VI.	„	1852	The Fossil Corals, Part III, Permian and Mountain-limestone, by Messrs. Milne Edwards and Jules Haime, 16 plates. The Fossil Brachiopoda, Vol. I, Part I, Tertiary, by Mr. Davidson, 2 plates. The Fossil Brachiopoda, Vol. I, Part II, No. 1, Cretaceous, by Mr. Davidson, 5 plates. The Fossil Brachiopoda, Vol. I, Part III, No. 2, Oolitic, by Mr. Davidson, 5 plates. The Eocene Mollusca, Part II, Pulmonata, by Mr. F. E. Edwards, 6 plates. The Radiaria of the Crag, London Clay, &c., by Prof. E. Forbes, 4 plates.
„ VII.	„	1853	The Fossil Corals, Part IV, Devonian, by Messrs. Milne Edwards and Jules Haime, 10 plates. The Fossil Brachiopoda, Introduction to Vol. I, by Mr. Davidson, 9 plates. The Mollusca of the Chalk, Part I, Cephalopoda, by Mr. D. Sharpe, 10 plates. The Mollusca of the Great Oolite, Part II, Bivalves, by Messrs. Morris and Lycett, 8 plates. The Mollusca of the Crag, Part II, No. 2, Bivalves, by Mr. S. V. Wood, 8 plates. The Reptilia of the Wealden Formations, Part I, Chelonia, by Prof. Owen, 9 plates.
„ VIII.*	„	1854	The Fossil Brachiopoda, Vol. I, Part II, No. 2, Cretaceous, with Appendix and Index to Vol. I, by Mr. Davidson, 8 plates. The Reptilia of the Wealden Formations, Part II, Dinosauria, by Prof. Owen, 20 plates. The Mollusca of the Great Oolite, Part III, Bivalves, by Messrs. Morris and Lycett, 7 plates. The Fossil Corals, Part V, Silurian, by Messrs. Milne Edwards and Jules Haime, 16 plates. The Fossil Balanidæ and Verrucidæ, by Mr. Charles Darwin, 2 plates. The Mollusca of the Chalk, Part II, Cephalopoda, by Mr. D. Sharpe, 6 plates. The Eocene Mollusca, Part III, No. 1, Prosobranchiata, by Mr. F. E. Edwards, 8 plates.
„ IX.†	„	1855	The Mollusca of the Crag, Part II, No. 3, Bivalves, by Mr. S. V. Wood, 11 plates. The Reptilia of the Wealden Formations, Part III, by Prof. Owen, 12 plates. The Eocene Mollusca, Part III, No. 2, Prosobranchiata, continued, by Mr. F. E. Edwards, 4 plates. The Mollusca of the Chalk, Part III, Cephalopoda, by Mr. D. Sharpe, 11 plates. The Tertiary Entomostraca, by Mr. T. R. Jones, 6 plates. The Fossil Echinodermata, Oolitic, Vol. I, Part I, by Dr. Wright, 10 plates.
„ X.	„	1856	The Fossil Echinodermata, Oolitic, Vol. I, Part II, by Dr. Wright, 12 plates. The Fossil Crustacea, Part I, London Clay, by Prof. Bell, 11 plates. The Fossil Brachiopoda, Vol. II, Part IV, Permian, by Mr. Davidson, 4 plates. The Fossil Brachiopoda, Vol. II, Part V, No. 1, Carboniferous, by Mr. Davidson, 8 plates. The Reptilia of the Wealden Formations, Part IV (Supplement No. 1), by Prof. Owen, 11 plates. The Reptilia of the London Clay, Vol. I (Supplement), by Prof. Owen, 2 plates.
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„ XIII.	„	1859	The Fossil Brachiopoda, Part V, No. 4, Carboniferous, by Mr. Davidson, 20 plates. The Reptilia of the Oolitic Formations, No. 1, Lower Lias, by Prof. Owen, 6 plates. The Reptilia of the Kimmeridge Clay, No. 1, by Prof. Owen, 1 plate. The Eocene Mollusca, Part IV, No. 1, Bivalves, by Mr. S. V. Wood, 13 plates.

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„ XV.	„ 1861	The Fossil Echinodermata, Oolitic, Vol. II, Part I (Asteroidea), by Dr. Wright, 13 plates. Supplement to the Great Oolite Mollusca, by Dr. Lycett, 15 plates.
„ XVI.	„ 1862	The Fossil Echinodermata, Cretaceous, Vol. I, Part I, by Dr. Wright, 11 plates. The Trilobites of the Silurian, Devonian, &c., Formations, Part I (Devonian and Silurian), by Mr. J. W. Salter, 6 plates. The Fossil Brachiopoda, Vol. III, Part VI, No. 1, Devonian, by Mr. Davidson, 9 plates. The Eocene Mollusca, Part IV, No. 2, Bivalves, by Mr. S. V. Wood, 7 plates. The Reptilia of the Cretaceous and Wealden Formations (Supplements), by Prof. Owen, 10 plates.
„ XVII.	„ 1863	The Trilobites of the Silurian, Devonian, &c., Formations, Part II, by Mr. J. W. Salter, 8 plates. The Fossil Brachiopoda, Vol. III, Part VI, No. 2, Devonian, by Mr. Davidson, 11 plates. The Belemnitidæ, Part I, Introduction, by Prof. Phillips. The Reptilia of the Liassic Formations, Part I, by Prof. Owen, 16 plates.
„ XVIII.	„ 1864	The Fossil Echinodermata, Oolitic, Vol. II, Part II (Liassic Ophiuroidea), by Dr. Wright, 6 plates. The Trilobites of the Silurian, Devonian, &c., Formations, Part III, by Mr. J. W. Salter, 11 plates. The Belemnitidæ, Part II, Liassic Belemnites, by Prof. Phillips, 7 plates. The Pleistocene Mammalia, Part I, Introduction, Felis spelæa, by Messrs. W. Boyd Dawkins and W. A. Sanford, 5 plates. Title-pages, &c., to the Monographs on the Reptilia of the London Clay, Cretaceous, and Wealden Formations.
„ XIX.*	„ 1865	The Crag Foraminifera, Part 1, by Messrs. T. Rupert Jones, W. K. Parker, and H. B. Brady, 4 plates. Supplement to the Fossil Corals, Part I, Tertiary, by Dr. Duncan, 10 plates. The Fossil Merostomata, Part I, Pterygotus, by Mr. H. Woodward, 9 plates. The Fossil Brachiopoda, Vol. III, Part VII, No. 1, Silurian, by Mr. Davidson, 12 plates.
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Vol. XXIV.*	Issued for the Year 1870	The Flora of the Carboniferous Strata, Part II, by Mr. E. W. Binney, 6 plates. The Fossil Echinodermata, Cretaceous, Vol. I, Part IV, by Dr. Wright, 10 plates. The Fossil Brachiopoda, Vol. III, Part VII, No. 4, Silurian, by Mr. Davidson, 13 plates. The Eocene Mollusca, Part IV, No. 3, Bivalves, by Mr. S. V. Wood, 5 plates. The Fossil Mammalia of the Mesozoic Formations, by Prof. Owen, 4 plates.
„ XXV.*	„ 1871	The Flora of the Carboniferous Strata, Part III, by Mr. E. W. Binney, 6 plates. The Fossil Merostomata, Part III, Pterygotus and Slimonia, by Mr. H. Woodward, 5 plates. Supplement to the Crag Mollusca, Part I (Univalves), by Mr. S. V. Wood, with an Introduction on the Crag District, by Messrs. S. V. Wood, jun., and F. W. Harmer, 7 plates and map. Supplement to the Reptilia of the Wealden (Iguanodon), No. IV, by Prof. Owen, 3 plates The Pleistocene Mammalia, Part IV, Felis pardus, &c., by Messrs. W. Boyd Dawkins and W. A. Sanford, 2 plates. The Pleistocene Mammalia, Part V, Ovibos moschatus, by Mr. W. Boyd Dawkins, 5 plates.
„ XXVI*	„ 1872	Supplement to the Fossil Corals, Part III (Oolitic), by Prof. Duncan, with an Index to the Tertiary and Secondary Species, 7 plates. The Fossil Echinodermata, Cretaceous, Vol. I, Part V, by Dr. Wright, 5 plates. The Fossil Merostomata, Part IV (Stylonurus, Eurypterus, Hemiaspis), by Mr. H. Woodward, 10 plates. The Fossil Trigoniæ, No. I, by Dr. Lycett, 9 plates.
„ XXVII.*	„ 1873	The Fossil Echinodermata, Cretaceous, Vol I, Part VI, by Dr. Wright, 8 plates. Supplement to the Fossil Brachiopoda, Vol. IV, Part I (Tertiary and Cretaceous), by Mr. Davidson, 8 plates. Supplement to the Crag Mollusca, Part II (Bivalves), by Mr. S. V. Wood, 5 plates. Supplement to the Reptilia of the Wealden (Iguanodon), No. V, by Prof. Owen, 2 plates. Supplement to the Reptilia of the Wealden (Hylæochampsa) No. VI, by Prof. Owen. The Fossil Reptilia of the Mesozoic Formations, Part I, by Prof. Owen, 2 plates.
„ XXVIII.*	„ 1874	The Post-Tertiary Entomostraca, by Mr. G. S. Brady, Rev. H. W. Crosskey, and Mr. D. Robertson, 16 plates. The Carboniferous Entomostraca, Part I (Cypridinadæ), by Prof. T. Rupert Jones and Messrs. J. W. Kirkby and G. S. Brady, 5 plates. The Fossil Trigoniæ, No. II, by Dr. Lycett, 10 plates.
„ XXIX.*	„ 1875	The Flora of the Carboniferous Strata, Part IV, by Mr. E. W. Binney, 6 plates. The Fossil Echinodermata, Cretaceous, Vol. I, Part VII, by Dr. Wright, 10 plates. The Fossil Trigoniæ, No. III, by Dr. Lycett, 8 plates. The Fossil Reptilia of the Mesozoic Formations, Part II, by Prof. Owen, 20 plates.
„ XXX.*	„ 1876	The Carboniferous and Permian Foraminifera (the genus Fusulina excepted), by Mr. H. B. Brady, 12 plates. Supplement to the Fossil Brachiopoda, Vol. IV, Part II, No. 1 (Jurassic and Triassic), by Mr. Davidson, 8 plates. Supplement to the Reptilia of the Wealden (Poikilopleuron and Chondrosteosaurus), No. VII, by Prof. Owen, 6 plates.
„ XXXI.*	„ 1877	Supplement to the Eocene Mollusca (Bivalves), by Mr. S. V. Wood, 2 plates. The Fossil Trigoniæ, No. IV, by Dr. Lycett, 13 plates. The Eocene Mollusca (Univalves), Part IV, by Mr. S. V. Wood, 1 plate. The Carboniferous Ganoid Fishes, Part I (Palæoniscidæ), by Dr. Traquair, 7 plates. The Fossil Reptilia of the Mesozoic Formations, Part III, by Prof. Owen, 2 plates. The Fossil Elephants (E. antiquus), Part I, by Prof. Leith Adams, 5 plates.
„ XXXII.*	„ 1878	The Fossil Echinodermata, Cretaceous, Vol. I, Part VIII, by Dr. Wright, 8 plates. Index and Title Page to the Fossil Echinodermata, Oolitic, Vol. I (Echinoidea), by Dr. Wright. The Fossil Merostomata, Part V (Neolimulus, &c.), by Dr. H. Woodward, 6 plates. Supplement to the Fossil Brachiopoda, Vol. IV, Part II, No. 2 (Jurassic and Triassic), by Mr. Davidson, 13 plates. The Lias Ammonites, Part I, by Dr. Wright, 8 plates. The Sirenoid and Crossopterygian Ganoids, Part I, by Prof. Miall, 6 plates. Supplement to the Reptilia of the Wealden (Goniopholis, Petrosuchus, and Suchosaurus), No. VIII, by Prof. Owen, 6 plates. The Pleistocene Mammalia, Part A (Preliminary Treatise), by Prof. Boyd Dawkins.

* These Volumes are issued in two forms of binding; first, with all the Monographs stitched together and enclosed in one cover; secondly, with each of the Monographs separate, and the whole of the separate parts placed in an envelope. The previous Volumes are not in separate parts.

CATALOGUE OF WORKS—Continued.

Vol. XXXIII.*	Issued for the Year 1879	The Eocene Flora, Vol. I, Part I, by Mr. J. S. Gardner and Baron Ettingshausen, 5 plates. Second Supplement to the Crag Mollusca (Univalves and Bivalves), by Mr. S. V. Wood, 6 plates. The Fossil Trigoniæ, No. V (*Conclusion*), by Dr. Lycett, 1 plate. The Lias Ammonites, Part II, by Dr. Wright, 10 plates. Supplement to the Reptilia of the Wealden (Goniopholis, Brachydectes, Nannosuchus, Theriosuchus, and Nuthetes), No. IX, by Prof. Owen, 4 plates. The Fossil Elephants (E. primigenius), Part II, by Prof. Leith Adams, 10 plates.
„ XXXIV.*	„ 1880	The Eocene Flora, Vol. I, Part II, by Mr. J. S. Gardner and Baron Ettingshausen, 6 plates. The Fossil Echinodermata, Oolitic, Vol. II, Part III (Asteroidea and Ophiuroidea), by Dr. Wright, 3 plates. Supplement to the Fossil Brachiopoda, Vol. IV, Part III (Permian and Carboniferous), by Mr. Davidson, 8 plates. The Lias Ammonites, Part III, by Dr. Wright, 22 plates. The Reptilia of the London Clay, Vol. II, Part I (Chelone) by Prof. Owen, 2 plates.
„ XXXV.*	„ 1881	The Fossil Echinodermata, Cretaceous, Vol. I, Part IX, by Dr. Wright, 6 plates. Supplement to the Fossil Brachiopoda, Vol. IV, Part IV (Devonian and Silurian, from Budleigh-Salterton Pebble Bed), by Mr. Davidson, 5 plates. The Fossil Trigoniæ (Supplement No. 1), by Dr. Lycett. The Lias Ammonites, Part IV, by Dr. Wright, 10 plates. The Reptilia of the Liassic Formations, Part III (*Conclusion*), by Prof. Owen, 13 plates. The Fossil Elephants (E. primigenius and E. meridionalis), Part III (*Conclusion*), by Prof. Leith Adams, 13 plates.
„ XXXVI.*	„ 1882	The Eocene Flora, Vol. I, Part III (*Conclusion*), by Mr. J. S. Gardner and Baron Ettingshausen, 2 plates. Third Supplement to the Crag Mollusca, by the late Mr. S. V. Wood, 1 plate. The Fossil Echinodermata, Cret., Vol. I, Part X (*Conclusion*), by Dr. Wright, 5 plates. Supplement to the Fossil Brachiopoda, Vol. IV, Part V (*Conclusion*), by Dr. Davidson. Do., Vol. V, Part I (Devonian and Silurian), by Dr. Davidson, 7 plates. The Lias Ammonites, Part V, by Dr. Wright, 22 plates.
„ XXXVII.*	„ 1883	The Eocene Flora, Vol. II, Part I, by Mr. J. S. Gardner, 9 plates. The Trilobites of the Silurian, Devonian, &c., Formations, Part V (*Conclusion*), by the late Mr. J. W. Salter. The Carboniferous Trilobites, Part I, by Dr. H. Woodward, 6 plates. Supplement to the Fossil Brachiopoda, Vol. V, Part II (Silurian), by Dr. Davidson, 10 plates. The Fossil Trigoniæ (Supplement No. 2), by the late Dr. Lycett, 4 plates. The Lias Ammonites, Part VI, by Dr. Wright, 8 plates.
„ XXXVIII.*	„ 1884	The Eocene Flora, Vol. II, Part II, by Mr. J. S. Gardner, 11 plates. The Carboniferous Entomostraca, Part I, No. 2 (*Conclusion*), by Prof. T. Rupert Jones, Mr. J. W. Kirkby, and Prof. G. S. Brady, 2 plates. The Carboniferous Trilobites, Part II, by Dr. H. Woodward, 4 plates. Supplement to the Fossil Brachiopoda, Vol. V, Part III (*Conclusion*), by Dr. Davidson, 4 plates. The Lias Ammonites, Part VII, by Dr. Wright, 10 plates.
„ XXXIX.*	„ 1885	The Eocene Flora, Vol. II, Part III (*Conclusion*), by Mr. J. S. Gardner, 7 plates. The Stromatoporoids, Part I, by Prof. Alleyne Nicholson, 11 plates. The Fossil Brachiopoda (Bibliography), Vol. VI (*Conclusion*), by the late Dr. Davidson and Mr. W. H. Dalton. The Lias Ammonites, Part VIII (*Conclusion*), by the late Dr. Wright, 1 plate.
„ XL.*	„ 1886	The Morphology and Histology of Stigmaria Ficoides, by Prof. W. C. Williamson, 15 plates. The Fossil Sponges, Part I, by Dr. G. J. Hinde, 8 plates. The Jurassic Gasteropoda, Part I, No. 1, by Mr. W. H. Hudleston. The Inferior Oolite Ammonites, Part I, by Mr. S. S. Buckman, 6 plates. The Pleistocene Mammalia, Part VI, by Prof. Boyd Dawkins, 7 plates.
„ XLI.*	„ 1887	The Fossil Sponges, Part II, by Dr. G. J. Hinde, 1 plate. The Palæozoic Phyllopoda, Part I, by Prof. T. R. Jones and Dr. Woodward, 12 plates. The Jurassic Gasteropoda, Part I, No. 2, by Mr. W. H. Hudleston, 6 plates. The Inferior Oolite Ammonites, Part II, by Mr. S. S. Buckman, 8 plates.

* These Volumes are issued in two forms of binding; first, with all the Monographs stitched together and enclosed in one cover; secondly, with each of the Monographs separate, and the whole of the separate parts placed in an envelope.

CATALOGUE OF WORKS—Continued.

Vol. XLII.*	Issued for the Year 1888		The Stromatoporoids, Part II, by Prof. Alleyne Nicholson, 8 plates. The Tertiary Entomostraca (Supplement), by Prof. T. Rupert Jones and Mr. C. D. Sherborn, 3 plates. The Jurassic Gasteropoda, Part I, No. 3, by Mr. W. H. Hudleston, 5 plates. The Inferior Oolite Ammonites, Part III, by Mr. S. S. Buckman, 10 plates. The Devonian Fauna of the South of England, Part I, by the Rev. G. F. Whidborne, 4 plates. Title-pages to the Monographs on the Reptilia of the Wealden and Purbeck (Supplements), Kimmeridge Clay, and Mesozoic Formations, and on the Cetacea of the Red Crag.
„ XLIII.*	„	1889	The Cretaceous Entomostraca (Supplement), by Prof. T. Rupert Jones and Dr. G. J. Hinde, 4 plates. The Jurassic Gasteropoda, Part I, No. 4, by Mr. W. H. Hudleston, 5 plates. The Inferior Oolite Ammonites, Part IV, by Mr. S. S. Buckman, 13 plates. The Devonian Fauna of the South of England, Part II, by the Rev. G. F. Whidborne, 12 plates.
„ XLIV.*	„	1890	The Stromatoporoids, Part III, by Prof. Alleyne Nicholson, 6 plates. The Fossil Echinodermata, Cretaceous, Vol. II, Part I (Asteroidea), by Mr. W. Percy Sladen, 8 plates. The Inferior Oolite Ammonites, Part V, by Mr. S. S. Buckman, 8 plates. The Devonian Fauna of the South of England, Part III, by the Rev. G. F. Whidborne, 9 plates. Title-pages to the Supplement to the Fossil Corals, by Prof. Duncan.
„ XLV.*	„	1891	The Jurassic Gasteropoda, Part I, No. 5, by Mr. W. H. Hudleston, 4 plates. The Inferior Oolite Ammonites, Part VI, by Mr. S. S. Buckman, 12 plates. The Devonian Fauna of the South of England, Part IV (*Conclusion of* Vol. I), 7 plates. „ „ Vol. II, Part I, by the Rev. G. F. Whidborne, 5 plates.
„ XLVI.*	„	1892	The Stromatoporoids, Part IV (*Conclusion*), by Prof. Alleyne Nicholson, 4 plates. The Palæozoic Phyllopoda, Part II, by Prof. T. R. Jones and Dr. Woodward, 5 plates. The Jurassic Gasteropoda, Part I, No. 6, by Mr. W. H. Hudleston, 6 plates. The Inferior Oolite Ammonites, Part VII, by Mr. S. S. Buckman, 20 plates. The Devonian Fauna of the South of England, Vol. II, Part II, by the Rev. G. F. Whidborne, 5 plates.
„ XLVII.*	„	1893	The Fossil Sponges, Part III, by Dr. G. J. Hinde, 10 plates. The Fossil Echinodermata, Cretaceous, Vol. II, Part II (Asteroidea), by Mr. W. Percy Sladen, 8 plates. The Inferior Oolite Ammonites, Part VIII, by Mr. S. S. Buckman, 16 plates. The Devonian Fauna of the South of England, Vol. II, Part III, by the Rev. G. F. Whidborne, 7 plates.

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§ II. LIST OF MONOGRAPHS

Completed, in course of Publication, and in Preparation.

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1. MONOGRAPHS which have been COMPLETED, and which may be bound as separate Volumes, with directions for the BINDING :—

The Morphology and Histology of Stigmaria ficoides by Prof. W. C. Williamson. (*Complete with Title-page and Index in the Volume for the year* 1886.)

The Eocene Flora, Vol. I (Filices), by Mr. J. S. Gardner and Baron Ettingshausen. (*Complete in the Volumes for the years* 1879, 1880, *and* 1882. *Title-page, Index, and directions for the binding, will be found in the Volume for* 1882.)

The Eocene Flora, Vol. II (Gymnospermæ), by Mr. J. S. Gardner. (*Complete in the Volumes for the years* 1883, 1884, *and* 1885. *Title-page, Index, and directions for the binding, will be found in the Volume for* 1885.)

The Carboniferous and Permian Foraminifera (the genus Fusulina excepted), by Mr. H. B. Brady. (*Complete in the Volume for the year* 1876.)

The Stromatoporoids, by Prof. Alleyne Nicholson. (*Complete in the Volumes for the years* 1885, 1888, 1890, and 1892. *The Title-page Index, and directions for binding will be found in the Volume for the year* 1892.)

The Tertiary, Cretaceous, Oolitic, Devonian, and Silurian Corals, by MM. Milne-Edwards and J. Haime. (*Complete in the Volumes for the years* 1849, 1851, 1852, 1853, *and* 1854. *The Title-page and Index, with corrected explanations of Plates XVII and XVIII, will be found in the Volume for the year* 1854.)

Supplement to the Tertiary, Cretaceous, Liassic, and Oolitic Corals, by Prof. Martin Duncan. (*Complete in the Volumes for the years* 1865, 1866, 1867, 1868, 1869, 1872, *and* 1890. *The Title-page, with directions for binding, will be found in the Volume for the year* 1890.)

The Polyzoa of the Crag, by Mr. G. Busk. (*Complete with Title-page and Index in the Volume for the year* 1857.)

The Tertiary Echinodermata, by Professor Forbes. (*Complete with Title-page in the Volume for the year* 1852.)

The Fossil Cirripedes, by Mr. C. Darwin. (*Complete in the Volumes for the years* 1851, 1854, *and* 1858. *The Title-page will be found in the Volume for the year* 1854, *and the Index in the Volume for the year* 1858.

The Post-Tertiary Entomostraca, by Mr. G. S. Brady, the Rev. H. W. Crosskey, and Mr. D. Robertson. (*Complete, with Title-page and Index, in the Volume for the year* 1874.)

The Tertiary Entomostraca, by Prof. T. Rupert Jones. (*Complete, with Title-page and Index, in the Volume for the year* 1855.)

The Cretaceous Entomostraca, by Prof. T. Rupert Jones. (*Complete, with Title-page and Index, in the Volume for the year* 1849.)

Supplement to the Cretaceous Entomostraca, by Prof. T. Rupert Jones and Dr. G. J. Hinde. (*Complete, with Title-page and Index, in the Volume for the year* 1889.)

The Carboniferous Entomostraca, Part I (Cypridinadæ and their allies), by Prof. T. Rupert Jones, Mr. J. W. Kirkby, and Prof. G. S. Brady. (*Complete in the volumes for the years* 1874 *and* 1884. *The Title-page and Index will be found in the Volume for the year* 1884.)

The Fossil Estheriæ, by Prof. T. Rupert Jones. (*Complete, with Title-page and Index, in the Volume for the year* 1860.)

The Trilobites of the Cambrian, Silurian, and Devonian Formations, by Mr. J. W. Salter. (*Complete in the Volumes for the years* 1862, 1863, 1864, 1866, *and* 1883. *The Title-page and Index, with directions for the binding, will be found in the Volume for the year* 1883.)

The Fossil Merostomata, by Dr. H. Woodward. (*Complete in the Volumes for the years* 1865, 1868, 1871, 1872, *and* 1878. *The Title-page and Index, with directions for the binding, will be found in the Volume for the year* 1878.)

The Fossil Brachiopoda (Tertiary, Cretaceous, Oolitic, and Liassic), Vol. I, by Mr. T. Davidson. (*Complete in the Volumes for the years* 1850, 1852, 1853, *and* 1854. *The Index will be found in the Volume for the year* 1854, *and corrected Title-page in that for* 1870.)

The Fossil Brachiopoda (Permian and Carboniferous), Vol. II, by Mr. T. Davidson. (*Complete in the Volumes for the years* 1856, 1857, 1858, 1859, *and* 1860. *The Index will be found in the Volume for the year* 1860, *and corrected Title-page in that for* 1870.)

The Fossil Brachiopoda (Devonian and Silurian), Vol. III, by Mr. T. Davidson. (*Complete in the Volumes for the years* 1862, 1863, 1865, 1866, 1868, *and* 1870. *The Title-page and Index will be found in the Volume for the year* 1870.)

The Fossil Brachiopoda, Vol. IV, by Dr. T. Davidson. Supplements: Tertiary, Cretaceous, Jurassic, Triassic, Permian, and Carboniferous. (*Complete in the Volumes for the years* 1873, 1876, 1878, 1880, 1881, *and* 1882. *The Title-page and Index, with directions for the binding will be found in the Volume for the year* 1882.)

The Fossil Brachiopoda, Vol. V, by Dr. T. Davidson. Supplements: Devonian and Silurian. Appendix to Supplements, General Summary, Catalogue and Index of the British Species. (*Complete in the Volumes for the years* 1882, 1883, *and* 1884. *The Title-page, with directions for the binding will be found in the Volume for the year* 1884.)

The Fossil Brachiopoda, Vol. VI, by Dr. T. Davidson and Mr. W. H. Dalton. Bibliography. (*Complete in the Volume for the year* 1885.)

The Eocene Bivalves, Vol. I, by Mr. S. V. Wood. (*Complete, with Title-page and Index, in the Volumes for the years* 1859, 1862, *and* 1870. *The directions for the binding will be found in the Volume for the year* 1870.)

Supplement to the Eocene Bivalves, by Mr. S. V. Wood. (*Complete, with Title-page and Index, in the Volume for the year* 1877.)

The Eocene Cephalopoda and Univalves, Vol. I, by Mr. F. E. Edwards and Mr. S. V. Wood. (*Complete in the Volumes for the years* 1848, 1852, 1854, 1855, 1858, *and* 1877. *The Title-page, Index, and directions for the binding, will be found in the Volume for the year* 1877.)

The Mollusca of the Crag, Vol. I, Univalves, by Mr. S. V. Wood. (*The Text, Plates, and Index, will be found in the Volume for the year* 1847, *and the Title-page will be found in the Volume for the year* 1855.)

The Mollusca of the Crag, Vol. II, Bivalves, by Mr. S. V. Wood. (*Complete in the Volumes for the years* 1850, 1853, 1855, 1858, *and* 1873. *The Title-page will be found in the Volume for the year* 1873, *and the Index will be found in the Volume for the year* 1855, *and a Note in the Volume for the year* 1858).

The Mollusca of the Crag, Vol. III, Supplement, by Mr. S. V. Wood. (*Complete in the Volumes for the years* 1871 *and* 1873. *The Title-page and Index will be found in the Volume for the year* 1873.)

Second Supplement to the Crag Mollusca, by Mr. S. V. Wood. (*Complete, with Title-page and Index, in the Volume for the year* 1879.)

Third Supplement to the Crag Mollusca, by Mr. S. V. Wood. (*Complete, with Title-page and Index, in the Volume for the year* 1882.)

The Great Oolite Mollusca, by Professor Morris and Dr. Lycett. (*Complete in the Volumes for the years* 1850, 1853, *and* 1854. *The Title-page and Index will be found in the Volume for the year* 1854.)

The Fossil Trigoniæ, by Dr. Lycett. (*Complete in the Volumes for the years* 1872, 1874, 1875, 1877, *and* 1879. *The directions for the binding will be found in the Volume for the year* 1879.)

Supplement to the Fossil Trigoniæ, by Dr. Lycett. (*Complete in the Volumes for the years* 1881 *and* 1883. *The Title-page, Index, with directions for the binding, will be found in the Volume for the year* 1883.)

The Oolitic Echinodermata, Vol. I, Echinoidea, by Dr. Wright. (*Complete in the Volumes for the years* 1855, 1856, 1857, 1858, *and* 1878. *Title-page, Index, and directions for the binding, will be found in the Volume for the year* 1878.)

The Oolitic Echinodermata, Vol. II, Asteroidea, by Dr. Wright. (*Complete in the Volumes for the years* 1861, 1864, *and* 1880. *Title-page, Index, and directions for the binding, will be found in the Volume for the year* 1880).

The Cretaceous Echinodermata, Vol. I, Echinoidea, by Dr. Wright. (*Complete in the Volumes for the years* 1862, 1867, 1869, 1870, 1872, 1873, 1875, 1878, 1881, *and* 1882. *The Title-page and Index, with directions for the binding, will be found in the Volume for the year* 1882.)

The Cretaceous (Upper) Cephalopoda, by Mr. D. Sharpe. (*Complete in the Volumes for the years* 1853, 1854, *and* 1855, *but wants Title-page and Index.*)

The Lias Ammonites, by Dr. Wright. (*Complete in the Volumes for the years* 1878, 1879, 1880, 1881, 1882, 1883, 1884, *and* 1885. *The Title-page and Index, with directions for the binding, will be found in the Volume for the year* 1885.)

The Fossils of the Permian Formation, by Professor King. *Complete, with Title-page and Index, in the Volume for the year* 1849. *Corrected explanations of Plates XXVIII and XXVIII* will be found in the Volume for the year* 1854.)

The Reptilia of the London Clay (and of the Bracklesham and other Tertiary Beds), Vol. I, by Professors Owen and Bell. (*Complete in the Volumes for the years* 1848, 1849, 1856, *and* 1864. *Directions for the binding, Title-page, and Index, will be found in the Volume for the year* 1864.) Part I of Vol. II, containing Chelone gigas (*to be found in the Volume for the year* 1880), can be added.

The Reptilia of the Cretaceous Formations, by Prof. Owen. (*Complete in the Volumes for the years* 1851, 1857, 1858, 1862, *and* 1864. *Directions for the binding, Title-page, and Index, will be found in the Volume for the year* 1864.)

The Reptilia of the Wealden and Purbeck Formations, by Professor Owen. (*Complete in the Volumes for the years* 1853, 1854, 1855, 1856, 1857, 1858, 1862, *and* 1864. *Directions for the binding, Title-pages, and Index, will be found in the Volume for the year* 1864.)

The Reptilia of the Wealden and Purbeck Formations (Supplements 4—9), by Professor Owen. (*Complete in the Volumes for the years* 1871, 1873, 1876, 1878, 1879, *and* 1888. *Directions for the binding, Title-page, Preface, and Table of Contents, will be found in the Volume for the year* 1888.)

The Reptilia of the Kimmeridge Clay Formation, by Professor Owen. (*Complete in the Volumes for the years* 1859, 1860, 1868, and 1888. *Directions for the binding, Title-page, Preface, and Table of Contents, will be found in the Volume for the year* 1888.)

The Reptilia of the Liassic Formations, by Professor Owen. (*Complete in the Volumes for the years* 1859, 1860, 1863, 1869, *and* 1881. *Directions for the binding, Title-pages, and Index, will be found in the Volume for the year* 1881.)

The Reptilia of the Mesozoic Formations, by Professor Owen. (*Complete in the Volume for the years* 1873, 1875, 1877, *and* 1888. *Directions for the binding, Title-page, Preface, and Table of Contents, will be found in the Volume for the year* 1888.)

The Red Crag Cetacea, by Professor Owen. (*Complete in the Volume for the years* 1869 *and* 1888. *Directions for the binding, Title-page, Preface, and Table of Contents, will be found in the Volume for the year* 1888.)

The Fossil Mammalia of the Mesozoic Formations, by Professor Owen. (*Complete, with Title-page and Table of Contents, in the Volume for the year* 1870.)

The Fossil Elephants, by Professor Leith Adams. (*Complete in the Volumes for the years* 1877, 1879, *and* 1881. *Directions for the binding, Title-page, and Index will be found in the Volume for the year* 1881.

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2. MONOGRAPHS in course of Publication :*—

The Eocene Flora, by Mr. J. S. Gardner.

The Fossil Sponges, by Dr. G. J. Hinde.

The Crag Foraminifera, by Messrs. T. Rupert Jones, W. K. Parker, and H. B. Brady.†

The Jurassic Gasteropoda, by Mr. W. H. Hudleston.

The Palæozoic Phyllopoda, by Prof. T. Rupert Jones and Dr. H. Woodward.

The Trilobites, by Dr. H. Woodward.

The Inferior Oolite Ammonites, by Mr. S. S. Buckman.

The Belemnites, by Professor Phillips.‡

The Sirenoid and Crossopterygian Ganoids, by Professor Miall.

The Fishes of the Carboniferous Formation, by Prof. Traquair.

The Fishes of the Old Red Sandstone, by Messrs. J. Powrie and E. Ray Lankester, and Professor Traquair.

The Pleistocene Mammalia, by Messrs. Boyd Dawkins and W. A. Sanford.

The Fauna of the Devonian Formation of the South of England, by the Rev. G. F. Whidborne.

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3. MONOGRAPHS which are promised or are in course of Preparation :*—

The Fossil Cycadeæ, by Mr. W. Carruthers.

The Graptolites, by Prof. Lapworth.

The Carboniferous Entomostraca, Part II (Leperditiadæ), by Prof. T. Rupert Jones.

The Wealden, Purbeck, and Jurassic Entomostraca, by Prof. T. R. Jones.

The Purbeck Mollusca, by Mr. R. Etheridge.

The Rhætic Mollusca, by Mr. R. Etheridge.

The Cambrian Fossils, by Dr. H. Hicks.

The Silurian Fish Bed, by Dr. Harley.

The Fossils of the Budleigh Salterton Pebble Bed, by the Rev. G. F. Whidborne.

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* Members having specimens which might assist the authors in preparing their respective Monographs are requested to communicate in the first instance with the Honorary Secretary.

† Will be finished by Prof. T. Rupert Jones.

‡ Unfinished through the death of the Author, but will be continued by Mr. G. C. Crick.

§ III. Dates of the Issue of the Yearly Volumes of the Palæontographical Society.

Volume	I	for	1847	was	issued	to	the	Members,	March, 1848.
,,	II	,,	1848	,,		,,		,,	July, 1849.
,,	III	,,	1849	,,		,,		,,	August, 1850.
,,	IV	,,	1850	,,		,,		,,	June, 1851.
,,	V	,,	1851	,,		,,		,,	June, 1851.
,,	VI	,,	1852	,,		,,		,,	August, 1852.
,,	VII	,,	1853	,,		,,		,,	December, 1853.
,,	VIII	,,	1854	,,		,,		,,	May, 1855.
,,	IX	,,	1855	,,		,,		,,	February, 1857.
,,	X	,,	1856	,,		,,		,,	April, 1858.
,,	XI	,,	1857	,,		,,		,,	November, 1859.
,,	XII	,,	1858	,,		,,		,,	March, 1861.
,,	XIII	,,	1859	,,		,,		,,	December, 1861.
,,	XIV	,,	1860	,,		,,		,,	May, 1863.
,,	XV	,,	1861	,,		,,		,,	May, 1863.
,,	XVI	,,	1862	,,		,,		,,	August, 1864.
,,	XVII	,,	1863	,,		,,		,,	June, 1865.
,,	XVIII	,,	1864	,,		,,		,,	April, 1866.
,,	XIX	,,	1865	,,		,,		,,	December, 1866.
,,	XX	,,	1866	,,		,,		,,	June, 1867.
,,	XXI	,,	1867	,,		,,		,,	June, 1868.
,,	XXII	,,	1868	,,		,,		,,	February, 1869.
,,	XXIII	,,	1869	,,		,,		,,	January, 1870.
,,	XXIV	,,	1870	,,		,,		,,	January, 1871.
,,	XXV	,,	1871	,,		,,		,,	June, 1872.
,,	XXVI	,,	1872	,,		,,		,,	October, 1872.
,,	XXVII	,,	1873	,,		,,		,,	February, 1874.
,,	XXVIII	,,	1874	,,		,,		,,	July, 1874.
,,	XXIX	,,	1875	,,		,,		,,	December, 1875.
,,	XXX	,,	1876	,,		,,		,,	December, 1876.
,,	XXXI	,,	1877	,,		,,		,,	February, 1877.
,,	XXXII	,,	1878	,,		,,		,,	March, 1878.
,,	XXXIII	,,	1879	,,		,,		,,	May, 1879.
,,	XXXIV	,,	1880	,,		,,		,,	May, 1880.
,,	XXXV	,,	1881	,,		,,		,,	May, 1881.
,,	XXXVI	,,	1882	,,		,,		,,	June, 1882.
,,	XXXVII	,,	1883	,,		,,		,,	October, 1883.
,,	XXXVIII	,,	1884	,,		,,		,,	December, 1884.
,,	XXXIX	,,	1885	,,		,,		,,	January, 1886.
,,	XL	,,	1886	,,		,,		,,	March, 1887.
,,	XLI	,,	1887	,,		,,		,,	January, 1888.
,,	XLII	,,	1888	,,		,,		,,	March, 1889.
,,	XLIII	,,	1889	,,		,,		,,	March, 1890.
,,	XLIV	,,	1890	,,		,,		,,	April, 1891.
,,	XLV	,,	1891	,,		,,		,,	February, 1892.
,,	XLVI	,,	1892	,,		,,		,,	November, 1892.
,,	XLVII	,,	1893	,,		,,		,,	December, 1893.

published be complete, *or in the* course of completion; *in the* SECOND *column, the yearly volumes which contain each particular Monograph (as a guide to binding the same); and in the* FOURTH *and following columns, the number of pages, plates, figures, and species described in the different Monographs.*

I. SUBJECT OF MONOGRAPH.	II. Dates of the Years *for which* the volume containing the Monograph was issued.	III *m*. Dates of the Years *in which* the Monograph was published.	IV. No. of Pages of Letterpress in each Monograph.	V. No. of Plates in each Monograph.	VI. No. of Lithographed Figures and of Woodcuts.	VII. No. of Species described in the Text.
The Morphology and Histology of Stigmaria ficoides, by Prof. W. C. Williamson, COMPLETE	1886	1887	66	15	91	1
The Eocene Flora, by Mr. J. S. Gardner and Baron Ettingshausen. Vol. I, COMPLETE	1879, 1880, 1882	1879, 1880, 1882	87	13	151	23
„ „ by Mr. J. S. Gardner. Vol. II, COMPLETE	1883, 1884, 1885	1883, 1884, 1886	159	27	400	31
The Flora of the Carboniferous Strata, by Mr. E. W. Binney, *in course of completion*	1867, 1870, 1871, 1875	1868, 1871, 1872, 1875	147	24	141	16
The Fossil Sponges, by Dr. G. J. Hinde, *in course of completion*.....	1886, 1887, 1893	1887, 1888, 1893	254	19	602	106
The Crag Foraminifera, by Messrs. T. Rupert Jones, W. K. Parker, and H. B. Brady, *in course of completion*	1865	1866	78	4	211	43
The Carboniferous and Permian Foraminifera, by Mr. H. B. Brady, COMPLETE.....	1876	1876	166	12	266	62
The Stromatoporoids, by Prof. Alleyne Nicholson, COMPLETE	1885, 1888, 1890, 1892	1886, 1889, 1891, 1892	237	29	415	44
The Tertiary, Cretaceous, Oolitic, Devonian, and Silurian Corals, by MM. Milne-Edwards and J. Haime, COMPLETE (*k*)	1849, 1851, 1852, 1853, 1854	1850, 1851, 1852, 1853, 1855	406	72	800	319*g*
Supplement to the Tertiary, Cretaceous, Oolitic, and Liassic Corals, by Prof. Duncan, COMPLETE	1865, 1866, 1867, 1868, 1869, 1872, 1890	1866, 1867, 1868, 1869, 1870, 1872, 1891	232	49	797	149
The Polyzoa of the Crag, by Mr. G. Busk, COMPLETE	1857	1859	145	22	641	122
The Tertiary Echinodermata, by Prof. Forbes, COMPLETE	1852	1852	39	4	144	44
The Oolitic Echinodermata, by Dr. Wright. Vol. I, COMPLETE (*l*)	1855, 1856, 1857, 1858, 1878	1857, 1858, 1859, 1861, 1878	491	43	724	120*h*
„ „ Vol. II, COMPLETE	1861, 1864, 1880	1863, 1866, 1880	207	22	232	35
The Cretaceous Echinodermata, by Dr. Wright. Vol. I, COMPLETE.....	1862, 1867, 1869, 1870, 1872, 1873, 1875, 1878, 1881, 1882	1864, 1868, 1870, 1871, 1872, 1874, 1875, 1878, 1881, 1882	390	87	1119	113
„ „ by Mr. W. Percy Sladen. Vol. II, *in course of completion*	1890, 1893	1891, 1893	66	16	173	19
The Fossil Cirripedes, by Mr. C. Darwin, COMPLETE	1851, 1854, 1858*a*	1851, 1855, 1861	137	7	320	54
The Fossil Merostomata, by Dr. H. Woodward, COMPLETE	1865, 1868, 1871, 1872, 1878	1866, 1869, 1872, 1872, 1878	265	36	365	51
The Post-Tertiary Entomostraca, by Mr. G. S. Brady, Rev. H. W. Crosskey, and Mr. D. Robertson, COMPLETE	1874	1874	237	16	515	134
The Tertiary Entomostraca, by Prof. Rupert Jones, COMPLETE	1855	1857	74	6	233	56
„ „ „ and Mr. C. D. Sherborn (Supplement), COMPLETE	1888	1889	55	3	134	48
The Cretaceous Entomostraca, by Prof. Rupert Jones, COMPLETE	1849	1850	41	7	176	31
„ „ „ and Dr. G. J. Hinde (Supplement)	1889	1890	78	4	258	46
The Carboniferous Entomostraca, by Prof. Rupert Jones and Messrs. J. W. Kirkby and Prof. G. S. Brady. Part I, COMPLETE.....	1874, 1884	1874, 1884	95	7	374	81
The Fossil Estheriæ, by Prof. Rupert Jones, COMPLETE	1860	1863	139	5	158	19*i*
		CARRIED FORWARD...	4291	549	9440	1767

SUBJECT OF MONOGRAPH.	II. Dates of the Years *for which* the volume containing the Monograph was issued.	III *m*. Dates of the Years *in which* the Monograph was published.	IV. No. of Pages of Letterpress in each Monograph.	V. No. of Plates in each Monograph.	VI. No. of Lithographed Figures and of Woodcuts.	VII. No. of Species described in the Text.
		BROUGHT FORWARD...	4291	549	9440	1767
The Palæozoic Phyllopoda, by Prof. Rupert Jones and Dr. H. Woodward, *in course of completion*	1887, 1892	1888, 1892	124	17	226	72
The Trilobites of the Cambrian, Silurian, and Devonian Formations, by Mr. J. W. Salter, COMPLETE	1862, 1863, 1864, 1866, 1883	1864, 1865, 1866, 1867, 1883	224	31	703	114
The Carboniferous Trilobites, by Dr. H. Woodward, COMPLETE	1883, 1884	1883, 1884	86	10	148	31
The Malacostracous Crustacea (comprising those of the London Clay, Gault, and Greensands), by Prof. T. Bell, *in course of completion*	1856, 1860	1858, 1863	88	22	215	50
The Fossil Brachiopoda, Vol. I. The Tertiary, Cretaceous, Oolitic, and Liassic Brachiopoda, by Mr. T. Davidson, COMPLETE	1850, 1852, 1853, 1854	1851, 1852, 1853, 1855	409	42	1855	160
„ „ Vol. II. The Permian and Carboniferous Brachiopoda, COMPLETE	1856*d*, 1857, 1858, 1859, 1860	1858, 1859, 1861, 1861, 1863	331	59	1909	157
„ „ Vol. III. The Devonian and Silurian Brachiopoda, COMPLETE	1862, 1863, 1865, 1866, 1868, 1870	1864, 1865, 1866, 1867, 1869, 1871	528	70	2766	321
„ „ Vol. IV. Supplements, Tertiary to Carboniferous, COMPLETE	1873, 1876, 1878, 1880, 1881, 1882	1874, 1876, 1878, 1880, 1881, 1882	383	42	1664	215
„ „ Vol. V. Supplements, Devonian and Silurian, COMPLETE	1882, 1883, 1884	1882, 1883, 1884	476	21	1135	116
„ „ Vol. VI. Bibliography, COMPLETE	1885	1886	163	—	—	—
The Fossil Trigoniæ, by Dr. Lycett, COMPLETE	1872, 1874, 1875, 1877, 1879	1872, 1874, 1875, 1877, 1879	246	41	446	115
Supplement to the Fossil Trigoniæ, by Dr. Lycett, COMPLETE	1881, 1883	1881, 1883	19	4	53	9*h*
The Mollusca of the Crag, by Mr. S. V. Wood:—						
Vol. I. (Univalves), COMPLETE	1847, 1855*b*	1848, 1857	216	21	581	244
Vol. II. (Bivalves), COMPLETE	1850, 1853, 1855, 1858*c*	1851, 1853, 1857, 1861	344	31	691	253
Supplements to the Crag Mollusca, No. I and II, by Mr. S. V. Wood, COMPLETE	1871, 1873, 1879	1872, 1874, 1879	322	18	517	232
„ „ No. III „ COMPLETE	1882	1882	24	1	29	13
The Eocene Mollusca, Cephalopoda and Univalves, by Mr. F. E. Edwards, continued by Mr. S. V. Wood. Vol. I, COMPLETE	1848, 1852, 1854, 1855, 1858, 1877	1849, 1852, 1855, 1857, 1861, 1877	361	34	625	275
The Eocene Mollusca, Bivalves, by Mr. S. V. Wood. Vol. I, COMPLETE	1859, 1862, 1870	1861, 1864, 1871	182	25	531	194
Supplement to the Eocene Mollusca, by Mr. S. V. Wood (Bivalves). Vol. I, COMPLETE	1877	1877	24	2	66	30
The Great Oolite Mollusca, by Prof. Morris and Dr. Lycett, COMPLETE	1850, 1853, 1854	1851, 1853, 1855	282	30	846	419
„ „ „ Supplement by Dr. Lycett, COMPLETE	1861	1863	129	15	337	194
The Jurassic Gasteropoda, by Mr. W. H. Hudleston, *in course of completion*	1886, 1887, 1888, 1889, 1891, 1892	1887, 1888, 1889, 1890, 1892, 1892	316	26	835	257
The Inferior Oolite Ammonites, by Mr. S. S. Buckman, *in course of completion*	1886, 1887, 1888, 1889, 1890, 1891, 1892, 1893	1887, 1888, 1889, 1890, 1891, 1892, 1892, 1893	376	93	962	146
The Liassic Ammonites, by Dr. Wright, COMPLETE	1878, 1879, 1880, 1881, 1882, 1883, 1884, 1885	1878, 1879, 1880, 1881, 1882, 1883, 1884, 1886	503	91	726	107
		CARRIED FORWARD...	10447	1295	27306	5491

I. SUBJECT OF MONOGRAPH.	II. Dates of the Years *for which* the volume containing the Monograph was issued.	III *m*. Dates of the Years *in which* the Monograph was published.	IV. No. of Pages of Letterpress in each Monograph.	V. No. of Plates in each Monograph.	VI. No. of Lithographed Figures and of Woodcuts.	VII. No. of Species described in the Text.
		BROUGHT FORWARD...	10447	1295	27306	5491
The Belemnites, by Prof. Phillips, *in course of completion*	1863, 1864, 1866, 1868, 1869	1865, 1866, 1867, 1869, 1870	128	36	622	69
The Upper Cretaceous Cephalopoda, by Mr. D. Sharpe, COMPLETE.....	1853, 1854, 1855	1853, 1855, 1857	67	27	319	79
The Fossils of the Permian Formation, by Prof. King, COMPLETE	1849, 1854*e*	1850, 1855	287	29	511	138
The Fauna of the Devonian Formation, by the Rev. G. F. Whidborne, Vol. I, COMPLETE.....	1888, 1889, 1890, 1891	1889, 1890, 1891, 1892	346	32	770	206
„ „ „ Vol. II, *in course of completion*	1891, 1892, 1893	1892, 1892, 1893	160	17	355	142
The Sirenoid Ganoids, by Prof. Miall, *in course of completion*	1878	1878	32	6	61	6
The Fishes of the Carboniferous Formation, by Dr. Traquair, *in course of completion*	1877	1877	60	7	58	5
The Fishes of the Old Red Sandstone, by Messrs. J. Powrie and E. Ray Lankester, *in course of completion*	1867, 1869	1868, 1870	62	14	195	21
The Reptilia of the London Clay [and of the Bracklesham and other Tertiary Beds], by Profs. Owen and Bell, Vol. I, COMPLETE ‡.....	1848, 1849, 1856*f*	1849, 1850, 1859	150	58	304	39
„ „ Vol. II, Part I, by Prof. Owen, COMPLETE.....	1880	1880	4	2	4	1
The Reptilia of the Cretaceous Formations, by Prof. Owen, COMPLETE‡.....	1851, 1857, 1858, 1862	1851, 1859, 1861, 1864	184	59	519	26
The Reptilia of the Wealden and Purbeck Formations (with Supplements 1, 2, 3), by Prof. Owen, COMPLETE ‡	1853, 1854, 1855, 1856, 1857, 1858, 1862	1853, 1855, 1857, 1858, 1859, 1861, 1864	155	62	251	17
The Reptilia of the Wealden and Purbeck Formations (Supplements 4—9), COMPLETE.....	1871, 1873, 1876, 1878, 1879, 1888*n*	1872, 1874, 1876, 1878, 1879, 1889	85	21	175	15
The Reptilia of the Kimmeridge Clay Formation, by Prof. Owen, COMPLETE	1859, 1860, 1868, 1888*n*	1861, 1863, 1869, 1889	16	6	23	4
The Reptilia of the Liassic Formations, by Prof. Owen, COMPLETE	1859,‖ 1860,‖ 1863, 1869, 1881*n*	1861, 1863, 1865, 1870, 1881	174	50	276	20
The Reptilia of the Mesozoic Formations, by Prof. Owen, COMPLETE	1873, 1875, 1877, 1888*n*	1874, 1875, 1877	101	24	165	17
The Red Crag Cetacea, by Prof. Owen, COMPLETE	1869, 1888*n*	1870, 1889	42	5	43	9
The Fossil Elephants, by Prof. Leith Adams, COMPLETE.....	1877, 1879, 1881*n*	1877, 1879, 1881	265	28	216	3
The Pleistocene Mammalia, by Messrs. W. Boyd Dawkins and W. A. Sanford, *in course of completion*	1864, 1867, 1868, 1871, 1878, 1886	1866, 1868, 1869, 1872, 1878, 1887	333	39	340	12
The Mammalia of the Mesozoic Formations, by Prof. Owen, COMPLETE	1870	1871	115	4	247	30
		TOTAL.....	13213	1821	32760	6350

a Index. *b* Title-page to Univalves. *c* Note to Crag Mollusca. *d* Contains the Permian. *e* Two corrections of Plates. *f* Supplement.
g Many of the species are described, but not figured. *h* British species only reckoned. *i* British species only reckoned. *k* A Supplement is now in course of publication.
l Index will be found in 1878 vol. *m* Useful for establishing the dates of new species. *n* Contains title-pages and directions for binding.
‡ Title-pages and Index will be found in the 1864 Volume. ‖ Marked on outside label 'Reptilia of Oolitic Formations.'

§ V. Stratigraphical Table *exhibiting the* British Fossils *already figured and described in the* Annual Volumes (1847—1893) *of the* Palæontographical Society.

	PLANTS.	PROTOZOA.		RADIATA.		ARTICULATA.					
		Sponges.	Foraminifera.	Stromatoporoids and Corals.	Echinodermata.	Cirripedes.	Cypridæ, Cytherinæ, &c.	Phyllopoda.	Merostomata.	Trilobites.	Malacostracous Crustacea.
Pleistocene	...	...	...	...	.....	.....	1874, 1888				
Crag	...	...	1865	1849	1852	1851, 1854	1888				
Eocene	1879, 1880, 1882, 1883, 1884, 1885	...	...	1849, 1865	1852	1851, 1854	1855, 1888	...	.....	.....	1856
Cretaceous.....	...	...	...	1849, 1868, 1869	1862, 1867, 1869, 1870, 1872, 1873, 1875, 1878, 1881, 1882, 1890, 1893	1851, 1854	1849, 1889	...	.....	.....	1860
Wealden	...	...	...	...	.....	.....	...	1860			
Oolitic	...	1893	...	1851, 1872	1855, 1856, 1857, 1858, 1861, 1878, 1880	1851	...	1860			
Liassic	...	1893	...	1851, 1866, 1867	1855, 1856, 1858, 1861, 1864						
Triassic	...	...	...	...	1880	.....	...	1860			
Permian	1849	1849	1849, 1876	1849, 1852	1849	.....	1849	1860			
Carboniferous...	1867, 1870, 1871, 1875, 1886	1887	1876	1852	.....	.....	1874, 1884	1860, 1887	1872, 1878	1883, 1884	
Devonian	...	1887	...	1853, 1885, 1888, 1890, 1892	.....	.....	1888	1860	1865, 1868, 1872, 1878	1862, 1888	
Silurian.	...	1886, 1887	...	1854, 1885, 1890	.....	.....	...	1887, 1892	1868, 1871, 1872, 1878	1862, 1863, 1864, 1866	
Cambrian	...	1886, 1887	...	1890	.....	.....	...	1887	.....	1864	

Note.—The numbers in the above List refer to the Volumes issued for those Dates.

STRATIGRAPHICAL TABLE *exhibiting the* BRITISH FOSSILS *already figured and described in the* ANNUAL VOLUMES (1847—1893) *of the* PALÆONTOGRAPHICAL SOCIETY (*continued*).

	MOLLUSCA.				VERTEBRATA.		
	Polyzoa.	Brachiopoda.	Monomyaria, Dimyaria, and Gasteropoda.	Cephalopoda.	Fishes.	Reptiles.	Mammalia.
Pleistocene	...	1873	.....	...	...	.....	1864, 1867, 1868, 1871, 1877, 1878, 1879, 1881, 1886
Crag	1857	1852, 1873, 1879	1847, 1850, 1853, 1855, 1871, 1873, 1879, 1882	...	...	.....	1869, 1881, 1888
Eocene	...	1852, 1873	1852, 1854, 1855, 1858, 1859, 1862, 1870, 1877	1848	...	1848, 1849, 1856, 1880	
Cretaceous.....	...	1852, 1854, 1873, 1884	1872, 1875, 1877, 1879	1853, 1854, 1855	...	1851, 1857, 1858, 1862, 1873, 1888	
Wealden	...	... ..	.....	...	...	1853, 1854, 1855, 1856, 1857, 1862, 1871, 1873, 1875, 1876, 1878, 1879	
Oolitic	...	1850, 1852, 1876, 1878, 1884	1850, 1853, 1854, 1872, 1874, 1875, 1877, 1879, 1883, 1886, 1887, 1888, 1889, 1891, 1892	1850, 1861, 1868, 1869, 1886, 1887, 1888, 1889 1890, 1891, 1892	...	(Purbeck) 1853, 1858 (Kim. Clay), 1859, 1860, 1868, 1873, 1875, 1877, 1888 (Great Oolite) 1875, 1888	1870
Liassic	...	1850, 1852, 1876, 1878, 1884	1874, 1877, 1879, 1883	1863, 1864, 1866, 1868, 1878, 1879, 1880, 1881, 1882, 1883, 1884, 1885,	...	1859, 1860, 1863, 1869, 1873, 1881	
Triassic.....	...	1876, 1878	1879	.....	1878	.....	1870
Permian	1849	1849, 1856, 1880	1849	1849	1849	1849	
Carboniferous ...	...	1856, 1857, 1858, 1859, 1860, 1880, 1884	.....	.....	1877		
Devonian	...	1862, 1863, 1881, 1882, 1884, 1893	1890, 1891, 1892, 1893	1889	1867, 1869		
Silurian.....	...	1865, 1866, 1868, 1870, 1881, 1882, 1883					
Cambrian							

NOTE.—The numbers in the above List refer to the Volumes issued for those Dates.

THE

PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCXLVII.

VOLUME FOR 1893.

LONDON:

MDCCCXCIII.

A MONOGRAPH

OF THE

BRITISH

FOSSIL SPONGES.

BY

GEORGE JENNINGS HINDE, Ph.D., F.G.S.

PART III.

SPONGES OF JURASSIC STRATA.

(Pages 189—254; Plates X—XIX.)

LONDON:
PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.
1893.

PRINTED BY ADLARD AND SON,
BARTHOLOMEW CLOSE, E.C., AND 20, HANOVER SQUARE, W.

PART III.

SPONGES OF JURASSIC STRATA.

INTRODUCTION.

In the series of rocks between the Yoredale beds of the Carboniferous Limestone and the Lower Lias there is an absence of fossil sponges in the British area, and throughout this interval (represented by the Millstone Grit, the Coal-Measures, the Magnesian Limestones and Red Marls of the Permian period, and the sandstones, marls, and shales of the Rhætic deposits) we can only suppose either that the conditions under which the strata were formed were unsuitable to sponge-life, or, what is perhaps more probable, that subsequent fossilisation has removed all traces of their existence. However this may be, it is certain that not until reaching the horizon of the Lower Lias do we find sponge remains in any abundance, and even here these organisms are only represented by detached spicules. In some beds of the Lower Liassic Limestones of Glamorganshire, near Brocastle and the neighbourhood, sponge-remains form, as pointed out by the late Mr. Charles Moore,[1] an important constituent of the rock. The beds are filled with spicules, in form resembling those of the still existing genus *Pachastrella*, Os. Schmidt, but their original silica has been removed and they now consist of carbonate of lime. Similarly some beds of limestone on the same geological horizon, near Shepton Mallet, Somersetshire, are crowded with detached spicules of siliceous sponges now replaced by calcite (Pl. XIII, fig. 4). At Harptree, in the same neighbourhood on the Mendip plateau, there are beds of chert of some considerable thickness belonging to nearly the same horizon as the limestones, which may very probably have been derived from the organic silica of sponges, although, with one or two exceptions, spicules are not recognisable in them.

[1] 'Quart. Journ. Geol. Soc.,' vol. xxiii, 1867, p. 538.

In the Middle Lias the only siliceous sponge yet known is a solitary specimen of the Lithistid genus *Platychonia* (Pl. XII, figs. 4, 4 *a*) discovered by the Rev. P. B. Brodie in the Marlstone at Ilminster. In some decayed rusty beds of the sand rock at King's Sutton, in Northamptonshire, Mr. E. A. Walford found the minute specimens of *Leucandra Walfordi*, Hinde (Pl. XIX, figs. 8—8 *c*), the earliest known fossil Calcisponges in this country, with the exception of some detached spicules occurring in Carboniferous strata, and further distinguished as the sole fossil representatives of the family of Leucones, very numerous in existing seas.

From the Upper Lias no sponges are as yet known in our area, but in the Inferior Oolite they occur in great abundance, and they form an important, though hitherto scarcely recognised, element of the fauna of this series.

In the lower division of the Inferior Oolite in the Cotteswold area, included in the zone of *Ammonites Murchisonæ*, an interesting group, inclusively of Calcisponges, has been brought to light through the researches of Mr. R. F. Tomes, Mr. F. Longe, and others. They mostly belong to *Peronidella tenuis*, Hinde; *Corynella punctata*, Hinde; *Lymnorella mamillosa*, Lamx.; *L. inclusa*, Hinde; *L. ramosa*, Hinde; and *Blastinia costata*, Goldfuss, and they occur more particularly in the Pea-grit series and in the Oolite-Marl of Crickley Hill, Cleve Hill, and Ravensgate Hill, near Cheltenham, and at Birdlip Hill, near Gloucester. Lately, Mr. E. Wethered has pointed out the occurrence of several of these species in a definite sponge-bed in the Pea-grit series, exposed in a railway cutting at Andoversford, near Cheltenham ('Quart. Journ. Geol. Soc.,' vol. xlvii, 1891, p. 553). In this lower division of the Inferior Oolite, sponges belonging to the genus *Lymnorella*, Lamx., are by far the most numerous; they frequently occur in nodular masses, partly incrusted by Polyzoa.

In the higher division of the Inferior Oolite, belonging to the zone of *Ammonites Parkinsoni*, British Jurassic sponges reach their greatest development. They are best shown in the grey limestone strata which cap the cliff at Burton Bradstock, near Bridport, Dorsetshire. Large masses of this limestone have in places fallen to the beach and have become weathered, and their upper surfaces show that the rock is mainly composed of masses of sponges growing attached to each other, apparently still in their natural position. The greater number are evidently siliceous sponges, but though they retain their original forms fairly well, their canal structures are largely obliterated, and the silica of their spicular skeletons has been entirely replaced by carbonate of lime, and thus they offer great difficulty in determining their character and relationships. The majority of the siliceous sponges in these beds are Hexactinellids, belonging to the genera, *Tremadictyon*, Zittel; *Calathiscus*, Sollas; *Craticularia*, Zittel; *Verrucocœlia*, Etallon; and *Stauroderma*, Zittel, but there are also several species of the

Lithistid genera *Platychonia*, Zittel, and *Leiodorella*, Zittel, as well as a few Calcisponges belonging to the genus *Peronidella*, Zittel.

At Shipton Gorge, not far from Burton Bradstock, in a quarry of the Inferior Oolite Limestone, on the same *Parkinsoni*-zone, Mr. E. A. Walford[1] discovered a thin sponge-bed containing an extraordinary number of small sponges associated with numerous species of Polyzoa. In contrast to the sponge-bed at the Burton Bradstock Cliff, which mostly consists of siliceous sponges, the Shipton Gorge bed is nearly entirely of Calcisponges belonging to the genera *Peronidella*, Zittel; *Holcospongia*, Hinde; *Lymnorella*, Lamx.; *Oculospongia*, Fromentel; and *Eudea*, Lamx.; and the specimens are mostly of small dimensions. Only a few broken-up fragments of siliceous sponges are present in the same bed with the Calcisponges, and in these the siliceous structure has been entirely replaced by calcite, whilst the Calcisponges are hardly at all altered in their mineral composition, thus showing that, under similar conditions, siliceous sponges have much less capacity for resisting the destructive effects of fossilisation than Calcisponges. In comparison with the difference of habitat in existing Hexactinellids and Calcisponges, it is interesting to note the joint existence of members of these groups in the same beds of the Inferior Oolite at this place. In some cases small Calcisponges still remain attached to the surface of Hexactinellids on which they have grown; whilst in others the basal dermal surfaces of Calcisponges retain the imprint of the cruciform, dermal spicules of sponges belonging to the genus *Stauroderma*, Zittel, which formerly served them as a basis of growth.

Beyond these two Dorsetshire localities there are but few others in the south-west of England which have yielded sponges in the upper beds of the Inferior Oolite. At Dundry Hill, near Bristol, the rare Lithistid, *Melonella ovata*, Sollas, sp., has been met with in the zone of *Am. Humphresianus*, and at Bradford Abbas, Dorset, a few specimens of *Peronidella* and *Holcospongia*.

Passing upwards to the Great Oolite series it is significant that only Calcisponges have as yet been found in these rocks in the British area. Members of this group are, however, by no means rare, and a very fine collection from the Great Oolite at Hampton Cliffs, near Bath, made by the late Mr. W. Walton, and presented by him to the Woodwardian Museum at Cambridge, has mainly served for the descriptions and figures given below. They are comprised in the following genera: *Peronidella*, *Eusiphonella*, *Corynella*, *Holcospongia*, *Lymnorella*, *Elasmostoma*, and *Diaplectia*. In the Forest Marble at Winsley, near Bath, in the Bradford Clay at Bradford-on-Avon, Wiltshire, and in the Cornbrash at Langton Herring, near Weymouth, a few Calcisponges also occur; those from the last-named places retain their spicular structure very perfectly.

Some beds in the well-boring at Richmond, Surrey, at 1205 feet beneath the

[1] 'Quart. Journ. Geol. Soc.,' vol. xlv, 1889, p. 561.

surface, which have been referred to the horizon of the Great Oolite, were found also to contain some small Calcisponges; these, however, appear to be more nearly related to the species from the Inferior Oolite at Shipton Gorge than to those from the Great Oolite near Bath, and it may be noticed that Mr. E. A. Walford has also found that several species of Polyzoa met with in the Richmond material associated with the small sponges, likewise occur in the Inferior Oolite at Shipton Gorge.

From the Kelloways Rock and the Oxford Clay proper, no sponges have been obtained, but in the different divisions of the Corallian series in Yorkshire, included in the zones of *Ammonites perarmatus* and *Am. plicatilis*, they again make their appearance, and sometimes in sufficient numbers to affect the character of the rock. Throughout the entire series only one species of siliceous sponge has been recorded, and this is the peculiar *Rhaxella perforata*, Hinde (Pl. XIII, figs. 7—7*f*), whose skeleton is made up of microscopic globate spicules. Examples of it occur in the Lower Calcareous Grit of Scarborough, and in the higher horizon of the Coral Rag at Settrington, Yorkshire. Though definite specimens of this sponge are rare, the detached microscopic globates, either of this or of other allied species, occur so abundantly as to form the larger part of considerable beds of rock and give rise to layers of chert of some thickness. Mr. W. H. Hudleston states that the lower part of the Lower Calcareous Grit at Scarborough consists of a poriferous mass of siliceous material not unlike a fine-grained sponge cake ('Proc. Geol. Ass.,' vol. iv, 1876, p. 384); the porous character being due to the solution of the minute, globate, sponge spicules which have left pinhole-like cavities in the rock.[1] In other instances the globates are preserved in a siliceous or calcareous matrix, and from this latter they can be obtained quite free by means of acid. The section at Scarborough Castle shows, according to Mr. Hudleston, a bed of chert, 3 feet 4 inches in thickness, and beneath this rough grits, 30 feet in thickness, belonging to the Lower Calcareous Grit, which are largely composed of these globate spicules. Hand-specimens of the grit from Falgrave Moor and other places near Scarborough, sent to me by Mr. Fox-Strangways, and from Filey, obtained by Mr. S. Chadwick, are mainly composed of these spicules. In the Coral Rag of North Grimston, Yorkshire, the same globates occur in great numbers, and Mr. Hudleston attributes the prevalent siliceous character of the Rag in this locality to the silica derived from these sponge remains. Similar detached spicules, unconnected with any definite form of sponge, have been described by Mr. J. F. Blake in the Coral Rag at Sturminster Newton, Dorsetshire, and at Hilmarton, near Colne, Wiltshire.

The Lower Calcareous Grit at Filey, and at Scarborough and the neighbour-

[1] An excellent description of the peculiar characters of this rock is also given by Mr. C. Fox-Strangways, 'Mem. Geol. Surv., Jurassic Rocks of Britain,' vol. i, Yorkshire, pp. 304 *et seq.*

hood, also contains a good many Calcisponges, principally belonging to *Holcospongia floriceps*, Phillips, sp., which frequently grows in colonies of considerable size.

This same species, together with *Holcospongia polita*, Hinde, and *Blastinia aspera*, Hinde, is fairly abundant in the Lower Limestone belonging to the upper part of the *Am. perarmatus*-zone at Suffield and Hackness, near Scarborough. Calcisponges are also fairly common in the white limestones of the higher horizons of the Corallian Oolite and Coral Rag at Langton Wold, near Malton, and at Settrington; they belong to *Corynella Langtonensis*, Hinde; *C. Chadwicki*, Hinde; and *Holcospongia glomerata*, Quenst., sp.

Though Calcisponges are abundant in the Corallian series of Yorkshire, they are rare in the corresponding beds in the South-west of England; only a few examples of *Holcospongia* are as yet known from the Coral Rag of Lyneham, Wiltshire.

From the Portland beds no entire fossil sponges are as yet known, but in some of the chert nodules in the limestones on the Isle of Portland and at Upway, near Weymouth, there are numerous detached spicules of *Pachastrella antiqua*, Moore, sp., and of *Geodites*, sp., thus showing that, in part at least, the chert of these rocks is derived from sponge remains.

In the fresh-water beds of the Purbeck series at Stare Cove, Dorsetshire, cherty nodules are present, and some of these were found by Mr. J. Young to be composed of minute acerate spicules which are referred to *Spongilla Purbeckensis*, Young.

From the different divisions of the British Jurassic series, fifty-six species of fossil sponges are described in the following pages; of these, twenty species are Siliceous sponges and thirty-six Calcisponges. The following list shows the numbers in each group:

	Siliceous Sponges.	Calcisponges.
Lias	2	1
Inferior Oolite	15	19
Great Oolite	—	14
Corallian	1	7
Portland Beds	2	—
Purbeck Beds	1	—

Very few species pass from one division to another; of the siliceous sponges, only one, *Pachastrella antiqua*, Moore, sp., which occurs at the bottom of the Lias and again in the Portland beds. Four species of Calcisponges are present both in the Inferior Oolite and in the Great Oolite, and one species is common to the Great Oolite and the Corallian rocks. Hexactinellid sponges have only been found in the Inferior Oolite, and here they are accompanied by Lithistids and Calcisponges.

Of the fifty-six species recognised in the British area, only nine occur in the

corresponding Jurassic strata of France, Germany, and Switzerland; but there are many other species closely allied to Continental forms. It is a noticeable fact that, as first mentioned by Prof. Sollas,[1] some of the species and nearly all the genera of Hexactinellid and Lithistid sponges present in the Inferior Oolite of Dorsetshire are similar to those which in Würtemberg and in the Swiss Jura appear in the distinctly higher horizon of the Upper, or White, Jura. Thus the genera *Tremadictyon*, *Verrucocœlia*, *Stauroderma*, *Platychonia*, and *Melonella*, together with *Craticularia clathrata*, Goldf., sp., and *C. foliata*, Quenstedt, sp., all recur in the Upper Jura in Germany. The Sponge-bed in the Inferior Oolite at Burton Bradstock, may well be compared in the number, variety, and mineral condition of its siliceous sponges with one of the zones of Spongiten-Kalk in the White Jura of Würtemberg. There is no sponge-bed in the corresponding middle Dogger in Germany to compare with that in our Inferior Oolite; and, on the other hand, there are no beds of Siliceous Hexactinellid sponges in our Corallian and Portland strata at all analogous to the sponge-zones in the Upper Jura of Germany.

The great abundance of Calcisponges forms the characteristic feature of the sponge fauna of our Jurassic rocks. In the Inferior Oolite the number of species exceeds that of the siliceous forms; in the Great Oolite there are fourteen species and no representative of siliceous sponges, and in the Corallian series there are seven species, as compared with a single species of siliceous sponges. Throughout the different divisions, the Calcisponges are fairly well preserved, their mineral structures are rarely altered, and in most of them the spicular character of the fibres can be recognised in thin sections, whilst in some the smallest spicules have been preserved intact.

In conclusion, I wish to acknowledge the generous assistance which I have received in the preparation of this part of the monograph. Mr. R. F. Tomes, of Evesham, Rev. G. F. Whidborne, Mr. F. Longe, of Cheltenham, and Mr. E. Wethered have supplied me with numerous specimens from the Pea-grit and the other beds of the Inferior Oolite. To my friend Mr. E. A. Walford, of Banbury, I am specially indebted for the beautiful little Calcisponges from the Middle Lias, and for the extraordinary variety and abundance of sponges which he obtained from the Inferior Oolite beds at Shipton Gorge. For the Yorkshire examples of Corallian sponges I am further indebted to the untiring energy and zeal of Mr. S. Chadwick, who has repeatedly sent me specimens and obtained for me the required information as to their occurrence. I also wish very heartily to thank Prof. T. McKenny Hughes for the opportunity of studying the unrivalled collection of Great Oolite Calcisponges in the Woodwardian Museum at Cambridge, and also to Mr. H. M. Platnauer my best thanks are due for the loan of valuable specimens from the Museum at York.

[1] 'Quart. Journ. Geol. Soc.,' vol. xxxix, 1883, p. 551.

DESCRIPTION OF GENERA AND SPECIES.

Jurassic Sponges.

Sub-order.—Hexactinellidæ.

Group.—Dictyonina.

Genus.—Tremadictyon, *Zittel.*

1877. Studien über fossile Spongien, I. Abhandl. der k. bayer. Akademie der Wiss., Cl. ii, Bd. xiii, Abth. i, p. 46.

Syn.—Scyphia, *Auct.* (in part); Cribrospongia, *d'Orbigny* (in part); Cribroscyphia, *Fromentel* (in part); Cribrocœlia, *Etallon* (in part); Retispongia, *Quenstedt* (in part).

Sponges cup-, platter-shaped, or cylindrical, with wide central cavity. On both the outer and inner surfaces of the wall there are tolerably large oval or rhomboidal ostia, disposed in rows alternately. Radial canals blind. The lattice-like skeleton of the wall and basal portion of the sponge consist of large irregular meshes, resulting from the frequent thickening and expansion of the spicular rays. The spicular nodes are compact. When well-preserved both surfaces of the wall are covered by an extremely delicate lattice-like membrane of amalgamated six-rayed spicules, which likewise extends over the ostia. The basal, or root, portion of the sponge is nodose and without ostia or canals. Type species *Tremadictyon* (*Scyphia*) *reticulata*, Goldfuss, sp. ('Petref. Germ.' vol. i, p. 11, pl. iv, figs. 1 *a*—*d*).

The above description is taken from that given by Von Zittel, based on specimens from the Upper Jura of Würtemberg, in which the skeletal structures have been preserved. The earliest recorded appearance of the genus is by Dunikowski, in the Lower Lias of Schafberg, near Salzburg ('Denkschriften der k. Akad. Wissensch. Wien,' vol. xlv, 1882, p. 179, pl. iv, figs. 42, 43); it occurs abundantly in the Swiss Jura, as well as in the Upper Jura of Würtemberg.

1. Tremadictyon sparsum, *Hinde*, sp. nov. Plate X, figs. 1, 1*a*.

Only fragments of this species are known, they indicate that the sponges were open cup-shaped, having walls from 4 to 12 mm. in thickness; the surface ostia are oval, ranging from 1·5 mm. to 3 mm. in length, and the mesh-walls between

them are from 1 mm. to 2 mm. in thickness. The spicular mesh, as seen in thin sections (Pl. X, fig. 1 *a*) is lax and irregular, bounding very unequal interspaces.

One of the largest fragments met with, figured on Pl. X, fig. 1, appears to be the upper portion of a large cup-shaped specimen, probably 150 mm. in diameter. Smaller fragments are not at all uncommon, but they are all in very unfavorable preservation; usually the ostia of only one surface are exposed, whilst the spicular structure is invariably replaced by calcite and very imperfectly shown. In the size and arrangement of the ostia the specimens resemble some fragments from the Upper Jura, which have been figured by Quenstedt as portions of *Tremadictyon reticulatum*, Goldf. ('Petrefactenkunde Deutschlands,' pl. cxv, figs. 1 *i*, 2 *i*), but it may be doubted if these really belong to the same species as Goldfuss's type. Further, the spicular mesh in the fragments from the Inferior Oolite (Pl. X, fig. 1 *a*), appears distinctly more irregular than in *T. reticulatum* from the Upper Jura of Germany, of which a small piece is figured for comparison (Pl. X, fig. 3).

Distribution.—Inferior Oolite. *Parkinsoni*-zone at Burton Bradstock, near Bridport, Dorset (Walton Coll., Woodwardian Museum, Cambridge).

2. Tremadictyon incertum, *Hinde*, sp. nov. Plate X, figs. 2, 4.

Cup- or funnel-shaped sponges with thick walls ranging from 18 to 30 mm. in thickness; the ostia of the outer surface are oval in form, and from 2 mm. to 4 mm. in diameter. The spicular mesh is very irregular and open. Fairly complete examples as well as large fragments of this species are known, but both the canal and spicular structures in all of them are now so indistinct that it is difficult to determine whether they properly belong to this genus or not.

The most complete specimen (Pl. X, fig. 4) is funnel-shaped, 125 mm. in height, by 90 mm. in width at the summit. Near the upper margin there are a few oval ostia shown, which appear to have been disposed closely in alternate rows; the rest of the surface is unevenly weathered, and no dermal layer is preserved, though in some places the irregular mesh of the skeleton can be seen. In sections of the sponge wall the spicular skeleton appears as an irregular network with very unequal meshes; the nodes are compact, but there are small apertures in some of them arising from the unequal deposition of the silica near the nodes. The canal structure cannot be made out with certainty. The interior of the sponge has been completely filled with the matrix of calcareous ooze, and the skeleton has been wholly replaced by calcite.

Distribution.—Inferior Oolite. *Parkinsoni*-zone in the Cliff-section at Burton Bradstock, Dorset. (Coll. G. J. Hinde.)

Genus.—Calathiscus, *Sollas.*

1883. Quart. Journ. Geol. Soc., vol. xxxix, p. 546.

Tubular, subcylindrical, or horn-shaped sponges; the interior cloacal cavity extending nearly from the base. The ostia of the outer surface circular to oval, numerous, disposed either irregularly or sometimes in rows alternately; the ostia on the inner surface distinctly larger than those on the outside of the wall. Canals sinuous, interdigitating with each other in the substance of the wall. The skeletal meshwork very irregular; some of the nodes are compact, whilst in others they are partially perforate but not regularly octahedral in character, as in *Ventriculites.*

3. Calathiscus variolatus, *Sollas.* Plate XI, figs. 1, 1 *a*—1 *c*.

1883. Calathiscus variolatus, *Sollas.* Quart. Journ. Geol. Soc., vol. xxxix, p. 546, pl. xxi, figs. 17—20.

The sponges are straight or slightly sinuous, horn-shaped, irregularly swollen at intervals, the base bluntly pointed or with a slight expansion. They range from 120 mm. to 160 mm. in height, and about 40 mm. in diameter in the upper portion. The walls are from 5 mm. to 6 mm. in thickness. The ostia of the outer surface are circular to oval in form, and vary from 1 mm. to nearly 2 mm. in diameter, whilst the interspaces between are about the same in width. The disposition of the ostia is masked by the weathering of the surface; in some places they appear to be irregular whilst in others they are alternate in vertical rows. The ostia of the cloacal surface are about 2 mm. in diameter. The skeleton in some places forms subquadrate meshes with compact nodes, in others the nodes show perforations, and there is no definite arrangement.

As in other siliceous sponges from the Inferior Oolite, the skeleton has been completely replaced by calcite. The specimens are not uncommon.

Distribution.—Inferior Oolite. *Parkinsoni*-zone in the Cliff at Burton Bradstock, Dorset. (Coll. Rev. G. F. Whidborne.)

Genus.—Craticularia, *Zittel.*

1877. Studien über fossile Spongien, I. Abhandlung der k. bayer. Akademie der Wiss., Cl. ii, Bd. xiii, Abth. i, p. 46.

Syn.—Scyphia, *Auct.* (in part); Cribrospongia, *d'Orbigny*, *F. A. Roemer* (in part); Goniospongia, *d'Orbigny* (in part); Dictyonocœlia, Cribrocœlia, Goniocœlia, *Etallon* (in part); Diplostoma, Dendrospongia, *F. A. Roemer* (in part); Eucoscinia, Desmoscinia, Phragmoscinion, Rhabdocnemis, Laocœtis, Hemicœtis, Brachiolites, *Pomel* (in part); Textispongia, Clathrispongia, *Quenstedt* (in part).

Sponges cup- or vase-shaped, cylindrical, tubular, simple, or branching. Both the outer and inner surface of the sponge-wall with numerous round or oval ostia disposed in regular vertical and transverse rows crossing each other at right angles; occasionally the ostia of one surface are disposed in longitudinal furrows. The radial canals are straight and terminate blindly, those from opposite surfaces alternating with each other. Skeleton very regular, forming equal meshes, with compact nodes. Occasionally there is a delicate dermal layer similar to that in *Tremadictyon*. The type species is *Craticularia* (*Scyphia*) *parallela*, Goldfuss, sp. ('Petref. Germ,' vol. i, p. 8, pl. iii, fig. 3). This genus is fairly common in the Jurassic strata of Germany and in the Cretaceous of this country.

4. Craticularia clathrata, *Goldfuss*, sp. Plate XI, fig. 5.

1826–33. Scyphia clathrata, *Goldfuss*. Petref. Germ., p. 8, pl. iii, figs. 1 *a*, *b*.
1877. Craticularia clathrata, *Zittel*. Studien, i, p. 46; Neues Jahrbuch, p. 355.
1878. Scyphia — *Quenstedt*. Petref. Deutschl., vol. v, p. 72, pl. cxvii, figs. 22—24.
1883. Craticularia — *Hinde*. Cat. Foss. Sponges, p. 94.

The only example of this species from British rocks, so far as yet known, is the lower portion of a vasiform specimen, 73 mm. in height by 49 mm. in width. The wall at the upper margin is 13 mm. in thickness. The roughened outer surface shows regularly-disposed oval ostia from 2 mm. to 3 mm. in width; the vertical rows are separated by nodose ridges, about 3 mm. in width. The ostia of the inner surface of the wall are situated in longitudinal furrows. The skeletal meshwork, as shown on a polished surface, is extremely regular, the sides of the

subquadrate meshes are about ·3 mm. in length. The original skeleton has been wholly replaced by calcite.

Distribution.—Inferior Oolite. *Parkinsoni*-zone in the Cliff-section at Burton Bradstock, Dorset. (Walton Coll., Woodwardian Museum.) It also occurs in the White, or Upper, Jura of Würtemberg, and at Randen, near Schaffhausen.

5. Craticularia foliata, *Quenstedt*, sp. Plate X, fig. 6—6 *b*.

1878. Textispongia foliata, *Quenstedt*. Petref. Deutschl., vol. v, p. 64, p. cxvii, figs. 7 *a*, *i*, *x*.

1883. Leptophragma fragile, *Sollas*. Quart. Journ. Geol. Soc., vol. xxxix, p. 545, pl. xx, figs. 10, 11, 11 *a*.

Entire form of sponge unknown, probably platter-shaped; the specimens consist of irregular broken fragments of a delicate plate-like wall, from 30 mm. to 50 mm. across, and from 2 mm. to 3 mm. in thickness. Both surfaces of the wall exhibit small, nearly circular ostia, about ·4 mm. wide, separated by interspaces of nearly equal width. The ostia are very regularly disposed so as to give an appearance of a minute quadrate reticulation to the surface. The canals extend at right angles nearly through the wall, and terminate blindly. The skeletal meshwork is very regular (Pl. X, fig. 6 *b*); the distance between the nodes is about ·125 mm., measured in thin sections of the wall.

These fragments agree so closely with those described and figured by Quenstedt, from the Upper Jura, below Mühlheim on the Danube, that there can be no doubt they belong to the same species. This author mentions that flattened fragments of the wall, a foot in width, occur in the shaly strata of this locality, so that the sponge must have reached considerable dimensions. Prof. Sollas did not adopt Quenstedt's name for this species, because, as he states, no magnified representation of the skeletal network was given; but, as a matter of fact, this has been figured by Quenstedt (l. c., fig. 7 *x*) and it corresponds closely with that of the British specimens.

Prof. v. Zittel has called attention to the fact that the spicular structure of the sponges with small ostia, which Quenstedt has ranged under *Textispongia*, is of a precisely similar character to that of the sponges with large ostia, placed by the same author under *Clathrispongia*, and that, consequently, both these divisions can be well included under *Craticularia* ('Neues Jahrbuch,' 1877, p. 708).

Distribution.—Inferior Oolite. *Parkinsoni*-zone in the Cliff-section at Burton Bradstock (Coll. Rev. G. F. Whidborne); and at Shipton Gorge (Coll. Mr. E. A.

Walford), Dorset. Also from the White Jura below Mühlheim, on the Danube (Quenstedt).

Genus.—Verrucocœlia, *Etallon.*

1859. Études paléontologiques sur les terrains jurassiques du Haut Jura. Monographie de l'étage Corallien. Mémoires de la Société d'Emulation du département du Doubs, s. iii, vol. iii, 1859, p. 537.

Syn.—Scyphia, *Auct*; Eudea, *d'Orbigny* (in part); Polycœlia, Cylindrospongia, *F. A. Roemer* (in part); Oncolpia, Rhabdocœlia, Plectodocis, Emplocia, Matoscinia, *Pomel;* Mastospongia, *Quenstedt* (in part); Mastodictyum, Plectospyris, *Sollas.*

Sponges compound, branching; the branches in some instances radiating from a central tube or cavity, in others they spring from a common base and inosculate with each other. The ostia of the walls are numerous, small, and without regular arrangement; canals nearly straight, those from opposite sides of the wall alternating with each other. The skeletal mesh regular, with compact nodes, as in *Craticularia.* The type species is *Verrucocœlia* (*Scyphia*) *verrucosa,* Goldfuss ('Petref. Germ.,' vol. i, p. 91, pl. xxxiii, figs. 8 *a*—*e*), from the middle beds of the White Jura, near Streitberg.

6. Verrucocœlia Whidborni, *Sollas*, sp. Plate XI, figs. 2, 2 *a*.

1883. Mastodictyum Whidborni, *Sollas.* Quart. Journ. Geol. Soc., vol. xxxix, pl. xx, figs. 7—9.

The type and hitherto the only known example of this species has a fan-shaped outline, measuring 110 mm. in width by 90 mm. in height; the basal portion is incomplete, but from it several main tubular branches are given off which subdivide and terminate in truncate, conical, teat-like tubes projecting either directly or obliquely upwards, whilst the direction of the main branches is nearly horizontal. These projecting tubes range up to 8 mm. in diameter; some are nearly sessile, whilst others extend about 16 mm. above the level of the basal branches, their summit apertures are from 2·5 mm. to 4 mm. in width. The ostia of the outer surface are about ·5 mm. in width. The spicular mesh is regular, and the distance between the nodes about ·15 mm.

This specimen was made, by Prof. Sollas, the type of a distinct genus, but in its mode of growth and in the character of the canals and spicular structure it sufficiently resembles some of the forms included by Prof. Zittel under *Verrucocœlia* to be included in this genus. The form appears to be very rare.

Distribution.—Inferior Oolite. *Parkinsoni*-zone in the Cliff-section at Burton Bradstock, Dorset. (Coll. Rev. G. F. Whidborne.)

7. Verrucocœlia elegans, *Sollas*, sp. Plate XI, figs. 3, 3 *a*.

1883. Plectospyris elegans, *Sollas*. Quart. Journ. Geol. Soc., vol. xxxix, p. 545, pl. xx, figs. 12—14.

The typical species, based on a single fragmentary specimen, consists of a small group, 50 mm. wide by 30 mm. in height, of short branching tubes, frequently intergrowing laterally with each other; the basal portion of these tubes is not preserved, so it cannot be told whether they originate from a common hollow base or not. The tubes are usually compressed, from 5 mm. to 8 mm. in diameter; their walls are from 2 mm. to 3 mm. in thickness, and slightly thickened at the summits. The ostia of the outer surface are closely but irregularly disposed, and about ·5 mm. in width; those of the inner surface appear to be arranged in longitudinal grooves. The skeletal mesh is regular, and the nodes are about ·16 mm. apart.

This specimen has also been made the type of a new genus, but it does not seem to be generically distinct from *Verrucocœlia*.

Distribution.—Inferior Oolite. *Parkinsoni*-zone in the Cliff-section at Burton Bradstock, Dorset. (Coll. Rev. G. F. Whidborne.)

8. Verrucocœlia major, *Sollas*, sp. Plate XI, fig. 4.

1883. Plectospyris major, *Sollas*. Quart. Journ. Geol. Soc., vol. xxxix, p. 546, pl. xx, figs. 15, 16.

The only known example of this species is contained in a small compact nodule of limestone, the upper surface of which shows the apertures of several tubes, with flattened, somewhat thickened margins. The tubes are from 8 mm. to 11 mm. in diameter, their walls 3·5 mm. in thickness, and the inner cavity 3·5 mm. in width.

The ostia are not shown. The spicular structure is closely similar to that of the preceding species, from which it mainly differs in the larger size of the tubes. So far as can be judged from the surface, the arrangement and character of the tubes in this form are very similar to those of *Verrucocœlia* (*Mastospongia*) *gregaria*, Quenstedt ('Petref. Deutschl.,' vol. v, p. 148, pl. cxxii, figs. 8—10) with which it also agrees in spicular structure.

Distribution.—Inferior Oolite. *Parkinsoni*-zone in the Cliff-section at Burton Bradstock, Dorset. (Coll. Rev. G. F. Whidborne.)

Genus.—Stauroderma, *Zittel.*

1877. Studien über fossile Spongien, I. Abhandl. der k. bayer. Akademie der Wiss., Cl. ii, Bd. xiii, Abth. i, p. 53.

Syn.—Scyphia, *Auct;* Cribrospongia, *d'Orbigny* (in part).

Infundibuliform or platter-shaped sponges with thick walls. The upper or inner surface with numerous apertures of cloacal tubes, whilst the under or outer surface of the wall is reticulate as in *Tremadictyon*. The canals pass obliquely through the wall, and after extending a distance beneath the inner surface open into the cloacal tubes. Skeleton mesh irregular, the nodes thickened or irregularly widened. Both surfaces of the wall furnished with a dermal layer consisting of moderately-sized, cruciform spicules cemented together. The type species is *Stauroderma* (*Spongites*) *Lochense*, Quenstedt ('Der Jura,' p. 669, pl. lxxxi, fig. 96), from the Upper Jura of Streitberg, Germany.

9. Stauroderma explanatum, *Hinde*, sp. nov. Plate X, figs. 5, 5 *a*.

The entire form of sponge unknown; the specimens consist of flattened plate-like fragments, some of which are 120 mm. in length by 80 mm. in width, whilst the walls reach to 16 mm. in thickness. The upper surface is smooth, with nearly circular oscular apertures about 4 mm. in diameter, regularly arranged in quincunx, about 10 mm. apart. The under surface is concealed by matrix. The spicular mesh of the interior, as seen in thin sections of the wall, is very irregular; the nodes are widened by unequal deposition of silica, so that the Hexactinellid character is completely masked. Here and there on the smooth upper surface, traces of the dermal layer can be distinguished. It consists of

cruciform spicules of moderate dimensions, about 1 mm. across; the spicules have no definite arrangement and their rays overlap each other irregularly. These spicules probably have a fifth ray which extends into the wall. In comparison with the specimens of *S. Lochense*, Quenstedt, sp., from the Upper Jura of Germany, the present form has the oscules of the upper surface smaller and more closely arranged and the wall does not attain the same thickness.

Distribution.—Inferior Oolite. *Parkinsoni*-zone in the Cliff-section at Burton Bradstock, Dorset. (Coll. Rev. G. F. Whidborne.)

Sub-order.—LITHISTIDÆ.

Family.—Rhizomorina.

Genus.—Platychonia, *Zittel.*

1878. Studien über fossile Spongien, II. Abhandl. der k. bayer. Akademie der Wiss., Cl. ii, Bd. xiii, Abth. i, p. 114.

Syn.—Spongites, Planispongia, *Quenstedt* (in part); Amorphospongia, *d'Orbigny* (in part).

Sponges with plate-like walls, either ear-shaped, undulating, or variously folded, less often cup- or platter-shaped. Both outer and inner surfaces of the wall with pores or ostia. Canal system scarcely distinguishable, in some instances apparently entirely limited to the labyrinthic interspaces formed by the skeleton, in others there are capillary-like tubes extending the entire length of the sponge and giving to it a fibrous, or radiate, appearance. The spicules consist of a main axis, usually curved; from the sides and ends of this spinous branches are given off. In some cases the lateral branches are so developed that the spicules can hardly be distinguished from the four-rayed Tetracladine spicules. The spicules are loosely interwoven so as to form an irregular meshwork.

The typical species is *Platychonia* (*Spongites*) *vagans*, Quenstedt, sp. ('Der Jura,' p. 679, pl. lxxxii, fig. 8), from the Upper, or White, Jura of Germany. As a rule, the sponges of this genus are so poorly preserved, that but little more than their form and mode of growth can be ascertained.

10. Platychonia Brodiei, *Sollas*. Plate XII, figs. 4, 4 *a*.

1885. Platychonia Brodiei, *Sollas*. Proc. Royal Dublin Society, N. S., vol. iv, p. 443, pl. xxi, figs. 4—6.

The only example of this species known is sessile, pouch- or fan-shaped, with incurved sides; it measures 55 mm. in height by 33 mm. across. Both the outer and inner surfaces are somewhat uneven, with slight rounded elevations and depressions. The ostia of the convex outer surface are subcircular, from ·2 mm. to .3 mm. wide; those of the inner surface are very indistinctly shown, but according to Professor Sollas they range up to ·4 mm. in diameter. There is no distinct canal system beyond that in the irregular interspaces of the skeleton. The spicules are slender, loosely connected together, without definite arrangement; they are almost entirely replaced by calcite.

Distribution.—Marlstone of the Middle Lias at Ilminster, Somerset. (Coll. Rev. P. B. Brodie.)

11. Platychonia elegans, *Sollas*. Plate XII, figs. 2—2 *b*.

1883. Platychonia elegans, *Sollas*. Quart. Journ. Geol. Soc., vol. xxxix, p. 547, pl. xxi, figs. 22—25.

Cf. 1858. Platychonia (Spongites) vagans, *Quenstedt*. Der Jura, p. 679, pl. lxxxii, fig. 8.

Sponges growing in the form of irregular undulating plates, from 5 mm. to 8 mm. in thickness, with curved and occasionally lobate margins. Surfaces uneven, with irregular hollows and ridges. When weathered, the upper surface exhibits a very fine reticulate network, with small circular or irregular pores, or ostia, from ·5 mm. to ·7 mm. in width; and a similar structure is present on the more uneven under-surface.

These sponges sometimes grow directly attached by the under surface of the wall to other sponges, as in the example figured (Pl. XII, fig. 2), where the sponge is growing on the Hexactinellid *Calathiscus variolatus*, Sollas; in other instances they have a short, blunted stem, or base, which is free. The specimens range from 50 mm. to 125 mm. in width. The originally siliceous skeleton has been replaced by calcite in all the specimens, and as a consequence the form of the individual spicules has been to a considerable extent obliterated, this more particularly happens where the branching extremities of the spicules interlock

together, and they are now only indicated in thin sections by patches of calcite with irregular outlines (Pl. XII, fig. 2 *b*). This will be better understood by comparison with the figures of a portion of the spicular mesh of a closely allied species, *Platychonia vagans*, Quenstedt, sp., in which the spicules retain their siliceous structure (Pl. XII, fig. 3). In its mode of growth and in the thickness of the walls this species has a considerable resemblance to *P. vagans*, but owing to its condition of preservation a close comparison is impracticable.

Distribution.—Inferior Oolite. *Parkinsoni*-zone in the Cliff-section at Burton Bradstock, Dorset. (Coll. Rev. G. F. Whidborne; G. J. Hinde.)

12. Platychonia tenuis, *Hinde*, sp. nov. Plate XII, figs. 6, 6 *a*.

Sponges consisting of thin plate-like walls, either ear-shaped or convolute; the walls are from 3·5 mm. to·5 mm. in thickness; the surfaces are fairly even though with occasional depressions. The outer surface has small circular or irregular ostia from ·2 mm. to ·5 mm. in width. The spicular mesh is of the same character as in *P. elegans*, but the component spicules are apparently smaller. The specimens range from 35 mm. to 68 mm. in width.

This species differs from *P. elegans* in its thinner walls, more even surfaces, and more delicate spicules.

Distribution.—Inferior Oolite. *Parkinsoni*-zone in the Cliff-section at Burton Bradstock, and at Shipton Gorge, Dorset. (Coll. G. J. Hinde; E. A. Walford.)

13. Platychonia affinis, *Hinde*, sp. nov. Plate XII, figs. 5, 5 *a*.

The only specimen referred to this species is platter-shaped, with an oval outline, 90 mm. across; it has a short, inversely-conical base, whilst the margins are rounded and in places thickened and recurved. The walls range from 5 to 10 mm. in thickness. The under or outer surface exhibits small rounded pores, or ostia, about ·4 mm. in width, bounded by the skeletal fibres; in places on the upper surface there are traces of horizontal canals from ·5 mm. to ·7 mm. in width. The skeletal mesh consists of fibres of loosely-arranged spicules which are now entirely replaced by calcite. In form and mode of growth and in the more distinctly fibrous character of the spicular mesh this species is distinguished from the preceding.

Distribution.—Inferior Oolite. *Parkinsoni*-zone at Burton Bradstock. (Coll. G. J. Hinde.)

Genus.—Leiodorella, *Zittel.*

1878. Studien über fossile Spongien, II. Abhandl. der k. bayer. Akademie der Wiss., Cl. ii, Bd. xiii, Abth. i, p. 113.

Syn.—Planispongia, Tragos, *Quenstedt* (in part).

Sponges with plate-like, ear-shaped, undulating walls, sometimes nodose or incrusting. Both surfaces of the wall covered with a smooth, apparently compact dermal layer which is perforated by oscules, and from these short curved canals extend into the wall and branch at their extremities. The skeleton consists of a moderately close mesh of spinous branching lithistid spicules with short simple axial canals. The dermal layer consists of small much-branched spicules. The typical species is *Leiodorella expansa*, Zittel, from the Upper Jura of Wodna, near Cracow. (' Studien,' ii, p. 113, pl. ii, fig. 5; pl. iii, fig. 11.)

14. Leiodorella contorta, *Hinde*, sp. nov. Plate XII, figs. 1, 1*a*.

Sponge growing in the form of an irregularly undulating, somewhat fan-shaped expansion, about 90 mm. in width by 60 mm. in height, with walls from 7 mm. to 10 mm. in thickness. The under surface is covered with a smooth dermal layer, which is penetrated by numerous irregularly disposed, sub-circular oscules from 1·25 mm. to 1·75 mm. in width and from 2 mm. to 3 mm. apart. The oscules do not now project beyond the surface, their margins are uneven, and they appear to serve as outlets for a variable number of canals, usually from two to four, which open into them. The upper surface of the sponge-wall is, to a great extent, concealed by matrix, but on grinding this away some sinuous horizontal canals are exposed, which may have extended beneath a dermal layer. The spicular mesh has been replaced by calcite, so that a thin section of the wall only shows a confused mass of interwoven spicules which form the fibres bordering the canals. In its appearance and general structure this sponge corresponds with some of the forms of *Platychonia* already described, but it can be readily distinguished from these by the smooth dermal layer with its numerous oscules. In the only other species of this genus yet described, *L. expansa*, Zittel, the oscules markedly project and they are less closely arranged than in the present form.

Distribution.—Inferior Oolite. *Parkinsoni*-zone in the Cliff-section at Burton Bradstock. (Coll. G. J. Hinde.)

Family.—Anomocladina.

Genus.—Melonella, *Zittel*.

1878. Studien über fossile Spongien, II. Abhandl. der k. bayer. Akademie der Wiss., Cl. ii, Bd. xiii, Abth. i, p. 134.

Syn.—Siphonia, *Goldfuss*, *Quenstedt* (in part); Emploca, Taxoploca, *Sollas*; Emploca, *Vosmaer*.

Subspherical, hemispherical, or ovate sponges; the lower portion either widened or supported on a short stem. Cloacal cavity deep, funnel-shaped, with the apertures of the excurrent canals arranged in longitudinal rows. The excurrent canals follow the curved contour of the sponge and open into the cloacal tube; the incurrent canals extend from the ostia on the surface in an obliquely curved direction towards the centre of the sponge. The skeleton consists of a close mesh of connected spicules of the Anomocladina type, like those of the genus *Cylindrophyma*, Zittel, in which, from twin nodes connected by a short rod-like axis, several arms or rays are given off which expand at the ends and connect with adjoining nodes (Part I, p. 71, fig. 5 *b*). The lower portion in some specimens is enveloped in a dermal layer.

The type species of this genus is *Melonella* (*Siphonia*) *radiata*, Quenstedt ('Der Jura,' p. 679, pl. lxxxii, fig. 13); from the Upper Jura of Heuberg. There is a close similarity in the canal system of this form to that of the Cretaceous genus *Siphonia*, but the spicular structure is markedly different.

15. Melonella ovata, *Sollas*, sp. Plate XIII, figs. 1, 1 *a*—*c*.

1883. Emploca ovata, *Sollas*. Quart. Journ. Geol. Soc., vol. xxxix, p. 542, pl. xx, figs. 1—6.

1887. — — *Vosmaer*. Porifera, Bronn's Klassen und Ordn. des Thier-Reichs, Bd. ii, p. 257.

1888. Taxoploca — *Sollas*. Challenger Report, Zoology, vol. xxv, p. xxviii.

Sponges ovate to sub-cylindrical, sessile, attached directly by their bases to shells or other bodies. Of the two specimens known one is 42 mm. in height by 30 mm. in diameter, whilst the other is 45 mm. by 22 mm. No dermal layer is present. The cloacal aperture is from 5 mm. to 6 mm. in diameter; the ostia of the surface are numerous, about ·5 mm. in width, and separated from each other by about the same interval. The canal structures are only partially shown in the specimen, which has been longitudinally sectioned; both the incurrent and excurrent canals appear to be nearly of an equal width, about ·5 mm. The

spicular mesh, which has been replaced by calcite, or in places dissolved away, leaving empty spaces in the matrix, is of a very close character; in thin sections it appears as a very fine reticulation, the nodes being connected by short rays; sometimes the meshes are subquadrate in outline. On the weathered surface of the sponge the minute spherical nodes of the spicules with their connecting rays stand out prominently and can be distinguished under the microscope (Pl. XIII, fig. 1 *c*). On comparing this structure with that of *Melonella radiata*, Quenstedt, of which there are several specimens in the British Natural History Museum, in the same condition of preservation, a very close resemblance is apparent. As in all the specimens of *Melonella*, the spicules in these sponges have been replaced by calcite. I have figured two of the siliceous spicules of *Cylindrophyma milleporatum*, Goldfuss, sp. (Pl. XIII, figs. 2, 2 *a*), for comparison with those of the present form.

This species was described by Prof. Sollas as the type of a new genus of Hexactinellid sponges characterised by having a canal system like that of the Lithistid genus *Siphonia*. There can be no doubt, however, that its spicular structure is really of the Anomocladina type, and that it is closely related to *Melonella radiata*. The mistake in its identification has arisen from the fact—as already remarked by Prof. v. Zittel—that the spicular structure of this group of Lithistids has often a deceptive resemblance to that of certain Hexactinellids, and more especially is this the case when the silica of the spicules has been replaced by calcite. Independently of the spicular structure, the general build and the character of the canal system in these sponges are sufficient to betray their relationship to typical Lithistids.

Distribution.—Inferior Oolite. *Humphresianus*-zone at Dundry Hill, near Bristol. (Coll. Rev. G. F. Whidborne.)

Sub-order.—TETRACTINELLIDÆ.

Genus.—Pachastrella.

16. Pachastrella antiqua, *Moore*, sp. Plate XIII, figs. 3, 4.

1867. Grantia antiqua, *Moore*. Quart. Journ. Geol. Soc., vol. xxiii, p. 538, pl. xvi, figs. 33, 34.
1878. Pachastrella antiqua, *Carter*. Ann. and Mag. Nat. Hist., ser. 5, vol. i, p. 418.
1883. — — *Sollas*. Quart. Journ. Geol. Soc., vol. xxxix, p. 542, note.
1883. — — *Hinde*. Cat. Foss. Sponges, B. Mus., p. 209, note.

Form of sponge unknown; the species is based on detached three- and four-rayed caltrop spicules; the rays in a small specimen are ·35 mm. in length by

.09 mm. in thickness, whilst in the largest form noticed they are 1 mm. in length by ·25 mm. in thickness. The rays are relatively robust, gradually tapering, with blunted ends.

These spicules were first noticed by the late Mr. Charles Moore, who states that they occur in such numbers in the Liassic limestones of South Wales as to constitute a material portion of the substance of the rock. As they are now of calcite Mr. Moore supposed that they belonged to a Calcisponge and placed them under the genus *Grantia*, Fleming, but Mr. Carter subsequently pointed out that from their form and proportions they must have been originally siliceous, and that they probably belonged to *Pachastrella*. The spicules are scattered irregularly in the grey liassic limestone, and weather out on the surface of the rock as minute whitish bodies, which can occasionally be obtained quite detached. In sections of limestone of the same age at Shepton Mallet these caltrop spicules are intermingled with acerate and trifid spicules belonging to other sponges (Pl. XIII, fig. 4). In all, the silica has now been replaced by granular calcite. The same forms also occur abundantly in beds of chert at Portland, similarly intermingled with other spicules. In this deposit they are siliceous, and sometimes they are found quite detached in a matrix of decayed chert.

Distribution.—Lower Lias conglomerate and limestone at Brocastle, Cowbridge, Southerndown, Glamorganshire, South Wales; Shepton Mallet, Somersetshire; Portland beds, in the cherty bands below the "Whit bed," on the Isle of Portland, and at Upway near Weymouth (Geol. Surv. Museum, Jermyn Street).

Genus.—Geodites, *Carter.*

17. Geodites, sp. (*a*). Plate XIII, fig. 5.

Trifid spicules with stout, straight, elongate shaft, and simple head-rays projecting obliquely forwards. In the specimen figured the shaft is 2·25 mm. in length by ·15 mm. in thickness, whilst the head-rays, of which only one is preserved entire, are ·45 mm. in length by ·1 mm. in thickness. These trifid spicules are fairly common in beds of Portland chert, associated with the *Pachastrella* spicules described above, but they are usually in a very fragmentary condition. They belong to a common type of zone-spicule, and differ but slightly in form and size from the trifid spicules of *Geodites antiquus*, from the Carboniferous limestones of Scotland and North Wales (Part II, p. 150, Pl. V., figs. 3 *a*—*d*); similar forms likewise occur in sponges from the Upper Chalk, and in existing sponges as well.

Distribution.—Portland beds; in the cherty bands below the "Whit bed," Isle of Portland.

18. Geodites, sp. (*b*). Plate XIII, fig. 5 *a*.

Trifid spicules, with straight, gradually tapering shafts, and short, nearly horizontally extended head-rays. Shaft 1·87 mm. in length by ·05 mm. in thickness; the head-rays are about ·102 mm. in length. Accompanying these are nearly straight, acerate spicules, 2 mm. in length by ·08 mm. in thickness, which probably belong to the same species. These spicules are now replaced by calcite; they occur in a limestone matrix infilling a species of *Tremadictyon*.

Distribution.—Inferior Oolite. *Parkinsoni*-zone in the cliff at Burton Bradstock. (Coll. G. J. Hinde.)

Family.—Rhaxellidæ, *Hinde*.

Sponges with walls of continuous, anastomosing, plate-like laminæ or trabeculæ, composed of agglomerated globate spicules of the same character as those forming the crust and axis of the existing genus *Placospongia*, Gray. ('Proc. Zool. Soc.,' 1867, p. 127.)

Genus.—Rhaxella, *Hinde*.

1890. Quart. Journ. Geol. Soc., vol. xlvi, p. 59.

Palmate, flabellate, or rarely funnel-shaped sponges; the laminated walls enclosing labyrinthic, intercommunicating channels and lacunæ, which open at the surface by sub-circular or elongate apertures.

19. Rhaxella perforata, *Hinde*. Plate XIII, figs. 7, 7 *a*—*f*.

1890.	Rhaxella perforata,		*Hinde*.	Quart. Journ. Geol. Soc., vol. xlvi, p. 59, pl. vi.
1891.	—	—	*Rauff*.	Neues Jahrb. für Mineralogie, &c., Bd. ii, p. 370.
1891.	—	—	*Blake*.	Proc. Geol. Assoc., vol. xii, p. 134.

These sponges occur as more or less weathered-out masses of irregular outlines, sometimes palmate or fan-shaped, at others with a deep funnel-shaped central cavity. All the specimens are imperfect, the largest measures 140 mm. in height by 80 mm. in width. The walls range up to 14 mm. in thickness, they consist of

plates or trabeculæ from ·5 mm. to 4 mm. in thickness, disposed so as to leave irregular channels and open spaces between them. The outer surface of the wall is smooth or slightly ribbed, and it is perforated by ovate or narrow slit-like apertures from 1 mm. to 9 mm. in width, whilst the interspaces between the plates, as seen in a transverse section of the wall, vary in width from 1 mm. to about 4 mm. (Pl. XIII, fig. 7 *b*). The wall-plates are entirely composed of small globate spicules, closely aggregated together (Pl. XIII, fig. 7 *c*). They are ellipsoidal or subspherical in form, with a small depression or hilum, which gives them a kidney-shaped appearance; in size they range between ·11 mm. and ·15 mm. in diameter; some smaller forms are, however, not more than ·08 mm. in thickness. As in the globates of existing species of *Geodia* and *Placospongia*, these fossil forms are composed of numerous minute spicular fibres or rods in close contact, which radiate from the centre of the spicule and terminate at the surface as small subcircular spots, ·002 mm. in width, regularly arranged in quincunx (Pl. XIII, figs. 7 *e*, 7 *f*). Many of these globates are nearly as perfect as those of existing sponges, and their structures are readily seen when examined in glycerine under the microscope, but the surfaces in others are extensively corroded, and the central portion in these is often changed into banded layers of chalcedony. The spicules are now usually cemented together to form the wall-plates by a secondary deposit of silica, and in some instances in the central portion of the wall their distinctive forms have been obliterated, and they are merged in a mass of chalcedony.

The skeleton in these sponges as now preserved to us appears wholly to consist of the globate spicules, and in this respect they markedly differ from all other sponges. In *Placospongia*, Gray, the nearest allied genus, there is, in addition to an inner axis and surface plates of globate spicules, an intermediate skeleton of pin-shaped spicules which seem to be wanting in this fossil form.

Connected examples of this species are rare, but detached globate spicules of a similar character to those composing these sponges are extremely abundant, so as to form in some instances the principal constituents of beds of cherty rock of considerable thickness in the Lower Calcareous Grit of Scarborough and the neighbourhood. They were first noticed by Dr. H. C. Sorby ('Quart. Journ. Geol. Soc.,' vol. vii (1851), pp. 1—6); ('Proc. Geol. and Polytechnic Soc. Yorkshire,' vol. iii (1851), pp. 197—206, Pl. IV), and subsequently by Mr. J. F. Blake ('Monthly Microscopical Journal,' vol. xv, 1876, pp. 262—264), and by Mr. W. H. Hudleston ('Proc. Geol. Assoc.,' vol. v, 1877, p. 443). The spicules were at first referred to perforate foraminifera, and named by Mr. Blake *Renulina Sorbyana*. As it is highly probable that these detached spicules may belong to more than a single species, I have preferred to give a particular designation to the forms described above.

Distribution.—Corallian; Lower Calcareous Grit; zone of *Ammonites perarmatus*, Scarborough (Coll. York Museum); Coral Rag, Settrington, Yorkshire. (Coll. W. H. Hudleston).

Detached spicules, some of which may belong to this species though no connected specimens have as yet been found in the same beds, occur in the Coral Rag, North Grimston, Yorkshire (W. H. Hudleston), and on nearly the same horizon at Sturminster Newton, Dorsetshire, and at Hilmarton, near Colne, Wiltshire. (F. J. Blake.)

Sub-order.—MONACTINELLIDÆ.

Family.—Spongillidæ.

Sponges inhabiting fresh water, with skeletons of acerate or cylindrical spicules and gemmulæ or statoblasts furnished with small amphidisc spicules or spined acerates differing from those of the skeleton. This family is very widely distributed geographically, but very rarely occurs in the fossil condition.

Genus.—Spongilla, *Lamarck.*

1815. Animaux sans vertèbres, tom. ii, p. 98.

The skeletal spicules are spined or smooth acerates. The gemmules are globular and covered with a layer of minute, spined acerate spicules, disposed tangentially.

20. Spongilla Purbeckensis, *Young.* Plate XIII, figs. 6, 6 *a*.

1878. Spongilla Purbeckensis, *Young.* Geol. Mag., dec. ii, vol. v, p. 220, fig. *b*.
1883. — — *Hinde.* Cat. Foss. Sponges, p. 21, pl. i, fig. 9.

The only remains of this species yet known are masses of detached spicules preserved in nodules of chert, in association with valves of *Cypris* and other fresh-water organisms. The spicules are exceedingly numerous, so as to constitute the main portion of the chert in which they occur; they are slightly curved acerates, smooth usually, but Mr. Young has noted some which are minutely spined; they have an average length of ·37 mm., the longest measured are ·415 mm. and from ·02 mm. to ·03 mm. in thickness. In some the axial canal is visible. The spicules

are crowded together irregularly, so that in a section of the chert some are cut transversely or obliquely, whilst others show their complete forms (Pl. XIII, fig. 6). Hitherto no definite evidence of the much smaller gemmule spicules has been discovered, and consequently it is not quite certain that the skeletal spicules really belong to *Spongilla* or to the allied genus *Meyenia*. The acerate skeleton spicules are about half as large again as those of the existing *Spongilla lacustris*, Linn.

Distribution.—Chert in the Purbeck limestones at Stare Cove, near Lulworth, Dorsetshire (Coll. J. F. Young; Geol. Survey Museum, Jermyn Street).

Order.—CALCISPONGIÆ.

Family.—Pharetrones.

Genus.—Peronidella,[1] *Zittel.*

21. Peronidella pistilliformis, *Lamouroux*, sp. Plate XIV, figs. 1—1*d*.

1821. Spongia pistilliformis, *Lamx.* Exposition méthod., p. 88, pl. lxxxiv, fig. 6.
1840–7. Scyphia pistilliformis, *Michelin.* Icon. Zooph., p. 250, pl. lviii, figs. 4*a*, *b*.
1854. — — *Morris.* Cat. Brit. Foss., p. 29.
1854. Spongia cymosa (?), *Morris.* Ibid., p. 30.
1859. Polycœlia pistilloides, *Fromentel.* Mém. Soc. Linn. de Normandie, vol. xi, No. 2, p. 32, pl. i, fig. 8.
1878. Peronella pistilliformis, *Zittel.* Studien, iii, p. 32.
1883. — repens, *Sollas.* Quart. Journ. Geol. Soc., vol. xxxix, p. 548, pl. xxi. fig. 31.
1883. — pistilliformis, *Hinde.* Cat. Foss. Sponges, p. 165, pl. xxxiii, figs. 1, 1*a*.

Sponges growing in bushy stocks or colonies, usually with a thickened procumbent base from which stems or branches are given off, which may either diverge or grow more or less in contact; in this latter case they frequently amalgamate laterally. The stems are either simple, or with lateral buds which

[1] Since the definition of this genus was given in Part II, p. 175, it has been discovered that the term "*Peronella*" was informally proposed by Dr. Gray in 1855, and adopted by A. Agassiz in 1872, for a genus or sub-genus of Echinoderms, and Prof. von Zittel has consequently proposed to modify the name for this genus of Calcisponges to "*Peronidella*."

form fresh branches, and sometimes again subdivide. The individual spongites are either subcylindrical, club-shaped, or ovoid, usually with a slight inflation at the summit, which is rounded, with a circular, well-defined cloacal aperture, usually from 1 to 1·5 mm., but sometimes 2 mm. in width. The colonies range from 25 to 63 mm. in width, and from 25 to 58 mm. in height; the spongites are from 3 to 6 mm. in thickness; just before division takes place some stems are 8 mm. in thickness.

The outer surface is only covered by a dermal layer in a narrow band wrapping round the bases of the stems and buds, and in certain places where there are indications of renewals of growth; the rest of the surface merely shows small oval or irregular apertures, bounded by the skeletal fibres, which at the surface are flattened. The wall fibres are comparatively stout, ranging from ·12 to ·33 mm. in thickness; they are composed of medium and small three-rayed spicules, perhaps also some four-rayed, very closely intermingled together (Pl. XIV, fig. 1 *c*). The rays vary from ·05 to ·22 mm. in length. The peculiar minute tuning-fork spicules are also present in the fibres (Pl. XIV, fig. 1 *d*). The outer portion of the fibres in some cases consists of a thin layer of filiform sinuous spicules, and occasionally similar spicules form a lining to the fibres bounding the cloacal tube.

There is considerable latitude both as regards the mode of growth and the size of the colonies and the individual spongites in the examples of this species, but there are so many gradational links that it is necessary to include all in one species. Both large and small spongites occur in the same colony, and on the same base may be found both cylindrical and club-shaped forms. Also in some colonies the stems diverge and extend outwards, whilst in others they are nearly upright and subparallel with each other.

This species appears to be very abundant in the Great Oolite, and a very fine series of specimens obtained from this formation at Hampton Cliffs near Bath are now in the Woodwardian Museum at Cambridge. The type of *Peronidella repens*, Sollas, is a fragment of a specimen of *P. pistilliformis*.

Distribution.—Great Oolite, Hampton Cliffs, near Bath; Stroud; Forest-Marble, Winsley, near Bath (E. A. Walford); Cornbrash, Langton Herring, near Weymouth.

Also in the 'Couche à polypiers,' at Langrune, Lebisey, Ranville, near Caen, France.

22. Peronidella tenuis, *Hinde*. Plate XIV, figs. 2, 2 *a*.

1883. Peronella tenuis, *Hinde*. Cat. Foss. Sponges, p. 166, pl. xxxiii, figs. 2, 2 *a*, 2 *b*.

Sponges growing in bushy masses of cylindrical or subcylindrical stems from 3 to 6 mm. in thickness. The main stems usually divide and give rise to two or three individuals which either grow in apposition, or slightly diverge from each other. The basal portion and the lower part of the stems are covered with a dermal layer. The summits are gently rounded, with a cloacal aperture about 1 mm. in width.

The skeletal fibres are slender, about ·1 mm. in width; near the outer surface they are somewhat closely arranged, but more open in the interior of the sponge-wall. The spicular structure is very imperfectly preserved, and the fibres now only show a series of three- or four-rayed spicules in the axial portion, enclosed by a fibrous crystalline layer.

Bushy masses of this species reach to 48 mm. in width by 35 mm. in height. From *P. pistilliformis* it is readily distinguished by the more slender character of the fibres and their different spicular structure. The type-specimen is in the British Natural History Museum.

Distribution.—Inferior Oolite. Pea-grit series, zone of *Ammonites Murchisonæ*, near Cheltenham. Also in the 'Couche à polypiers,' at Ranville, near Caen, France.

23. Peronidella Metabronnii, *Sollas*. Plate XIV, figs. 4—4 *f*.

1883. Peronella Metabronnii, *Sollas*. Quart. Journ. Geol. Soc., vol. xxxix, p. 548, pl. xxi, figs. 26, 27.

Sponges simple, subcylindrical or obconical in form, with a thickened, frequently expanded, foot-like base, straight or slightly curved, the summits flat or oblique, and with a relatively wide cloacal aperture. The walls are somewhat thin, so that the specimens are now frequently collapsed. The outer surface consists of an irregular mesh of fibres with very unequal interspaces (Pl. XIV, fig. 4 *d*). The cloacal tube is subcylindrical or funnel-shaped, its bounding wall of thickened fibres perforated by oval apertures about ·35 mm. in width, arranged alternately in vertical rows (Pl. XIV, figs. 4 *c*, 4 *e*). No special dermal layer is present. The

specimens range from individuals not more than 7 mm. in length to large forms 45 mm. in length by 11 mm. in diameter. In these latter the cloacal aperture is 6 mm. in width.

The skeletal fibres of the inner portion of the wall vary from ·1 to ·17 mm. in thickness, as measured in a transverse section; those of the outer surface are ·2 mm., whilst bordering the cloacal tube the fibres are ·25 mm. thick. The spicular structure is very indistinctly shown; it consists of three- and perhaps four-rayed spicules. Only occasionally can complete rays be distinguished; one of these measures ·27 mm. in length by ·03 mm. in thickness. The spicules vary considerably in size; they are irregularly but closely disposed in the fibres in the same way as in *P. pistilliformis*.

This species is fairly abundant in the Inferior Oolite. In all cases they are simple in their mode of growth, though occasionally one individual may have attached itself to the surface of another for support. Sometimes they appear to have grown on the surfaces of Hexactinellid sponges, for the under surface of the expanded base bears the imprint of cruciform spicules like those of the dermal layer of *Stauroderma*.

As remarked by Professor Sollas, there is a considerable resemblance in the form and mode of growth of this species to some of the forms of *Scyphia Bronnii*, Goldfuss, as figured by Quenstedt from the White Jura of Oerlinger and Nattheim ('Petref. Deutschl.,' vol. v, p. 183, pl. cxxiv, figs. 1—9). The main difference appears to be that in this latter form there are, according to Prof. v. Zittel, well-developed horizontal canals, which are not present in *P. Metabronnii*.

Distribution.—Inferior Oolite. *Parkinsoni*-zone at the Cliff-section, Burton Bradstock (Rev. G. F. Whidborne; G. J. Hinde), Shipton George (E. A. Walford), Bradford Abbas (R. F. Tomes), Dorset.

24. Peronidella Waltoni, *Hinde*, sp. nov. Plate XIV, figs. 3—3 *c*.

Sponges forming colonies of subcylindrical stems, which frequently diverge from each other, and give off short, stumpy lateral branches. The main stems usually uneven with occasional swellings and nodosities; the summits are obtusely conical or truncate. They range from 20 to 74 mm. in length, and from 7 to 12 mm. in thickness. The walls are thick, varying between 2 and 4 mm., the cloacal tube subcylindrical, from 2·5 to 5 mm. in width; it extends throughout the length of the sponge. The aperture is circular or oval, 4 to 5 mm. in width, the margins entire. The outer surface in some specimens is fairly smooth, and perforated with

small circular apertures from ·3 to ·5 mm. in width, whilst in others this surface layer is absent or partially worn away, and then there are irregular apertures bounded by the fibres. The apertures leading into the cloacal tube are round or oval, and without definite arrangement.

A transverse section shows that the fibres bordering the exterior and the cloacal tube are much thicker than those of the inner portion of the wall (Pl. XIV, fig. 3 *c*). They range from ·16 to ·8 mm. in width. The structure is similar to that of *P. pistilliformis*, but the stouter fibres have a marginal layer of filiform spicules. The largest ray of a three-rayed spicule is ·3 mm. in length by ·025 mm. in thickness.

This species is fairly common, but it is rarely found perfect, the stems being usually in fragments. The form apparently nearest allied is *Peronidella cymosa*, Michelin, sp. (*non* Lamouroux) ('Iconogr. Zoophy.,' p. 249, pl. lviii, fig. 3 *a*), but the stems are smaller and more regular in their growth. Some of the forms included under *Peronidella clavarioides*, Lamouroux, sp. ('Expos. méthod.,' p. 88, pl. lxxxiv, figs. 8—10), are similar in form, but their fibres are more delicate, and the margins of the oscules are notched by surface canals.

Distribution.—Great Oolite. Hampton Cliffs, near Bath. The type-specimens are from the Walton Collection in the Woodwardian Museum, Cambridge.

25. Peronidella recta, *Hinde*, sp. nov. Plate XV, figs. 1—1*c*.

Sponges growing either singly or in small colonies of from two to four cylindrical pipe-like individuals with truncate summits, which range from 11 mm. to 20 mm. in length, and from 4 mm. to 7 mm. in thickness. The spongites usually grow from a thickened base, and they have generally been attached laterally to the spines of Echinoderms, which have now left an impress in a deep transverse furrow (Pl. XV, fig. 1). The outer surface is smooth with closely arranged fibres forming very irregular interspaces. The cloacal aperture is circular, about 1·5 mm. in width. The fibres, as seen in section, are from ·07 mm. to ·17 mm. in thickness: only the larger three-rayed spicules are shown with any distinctness; their rays range up to ·2 mm. in length by ·035 mm. in thickness.

Distribution.—Corallian. Lower Calcareous Grit. Zone of *Ammonites perarmatus;* at Suffield, near Scarborough. (Collected by Mr. S. Chadwick.)

26. Peronidella nana, *Hinde*. Plate XV, figs. 2—2 *g*.

1884. Peronella nana, *Hinde*. Quart. Journ. Geol. Soc., vol. xl, p. 780, pl. xxxv, figs. 2, 2 *a*.

Sponges small, for the most part growing singly, but occasionally two or three individuals are attached to a common base, globular, pear-shaped, or subcylindrical, attached either directly by a small basal expansion or supported on a short pedicle. The summits are rounded or subtruncate, with a circular or elongate cloacal aperture from 1 mm. to 2 mm. in width. The dermal layer is restricted to a narrow band round the base, or is sometimes altogether wanting. The specimens range from 4 mm. to 11 mm. in height, and from 3·5 mm. to 7 mm. in breadth.

The outer surface exhibits subcircular or irregular apertures, from ·1 mm. to ·5 mm. in width. The fibres are stouter in some specimens than in others, and the apertures somewhat larger. In transverse section of the wall the fibres of the outer surface are sometimes ·25 mm. in thickness, whilst those of the interior vary from ·05 mm. to ·14 mm. The cloacal tube extends nearly to the base of the sponge. The spicular structure of the fibres is very imperfectly shown : it appears mainly to consist of three-rayed spicules ; in some instances there is a marginal layer of filiform spicules.

This species was originally founded on two small specimens from the Richmond well-boring ; numerous similar forms have since been obtained by Mr. E. A. Walford from Shipton Gorge. Amongst these there are certain differences in form and size, but they are all connected by intermediate variations, and seem to belong to one species.

Distribution.—Inferior Oolite. *Parkinsoni*-zone at Shipton Gorge, Dorset (Coll. E. A. Walford) ; and at Bradford Abbas (Mr. R. F. Tomes). Also in the Middle Oolite of the Richmond (Surrey) well-boring, at 1205 feet beneath the surface (Prof. J. W. Judd).

Genus.—Eusiphonella, *Zittel*.

1878. Studien über fossile Spongien, III. Abhandl. der k. bayer. Akademie der Wiss., Cl. ii, vol. xiii, pt. 2, p. 124.

Syn. Scyphia, *Goldfuss* (in part) ; Siphonocœlia, Discœlia, *Fromentel* (in part) ; Pareudea, *Etallon* (in part).

Sponges either simple or branching. The individual spongites are cylindrical, somewhat contracted below, thin-walled, with a wide tubular or funnel-shaped cloacal cavity, which extends from the base of the sponge. Wall of the cloacal

tube with elongated ostia, disposed in vertical rows which serve as the apertures of horizontal radial canals. The skeletal fibres are delicate, and form a loose meshwork. The outer surface provided with pores or small ostia. This genus may be distinguished from *Peronidella* by the presence of a system of horizontal canals. The type of the genus is *Eusiphonella* (*Scyphia*) *Bronnii*, Goldfuss, sp. ('Petref. Germ.,' vol. i, p. 91, pl. xxxiii, fig. 9), from the Upper Jura of Würtemberg.

27. Eusiphonella prolifera, *Hinde*, sp. nov. Plate XV, figs. 5, 5 *a*.

Sponges growing in large masses of frequently branching spongites, which radiate from a centre and extend both horizontally and vertically. The type-form is 170 mm. in length, 130 mm. broad, and 100 mm. in height. The individual spongites are cylindrical, straight or curved, with slightly swollen summits, which are, however, flat above. The longest individual measured is 27 mm., and they range from 6 mm. to 9 mm. in thickness. The branching usually takes place from the summit of the stems, which become tumid and give off two or three buds or short branches, which either grow parallel with the mother stem or slightly diverge from it. The spongites thus open all round the mass, and in the type-specimen there are more than one hundred of them.

The outer surface consists of minute scattered subcircular ostia, about ·4 mm. in width, with irregular porous interspaces between them. The cloacal apertures are from 2·5 mm. to 3 mm. in width. The interior surface of the cloacal tube has numerous delicate projecting longitudinal ridges, and the small elongate ostia are situated in the intermediate furrows. The spicular fibres are delicate, principally of three-rayed spicules, which, however, are very imperfectly shown in section; filiform spicules are present in places on the outer portion of the fibres. In transverse section the fibres range from ·08 mm. to ·18 mm. in thickness.

Besides its larger habit of growth, this species differs from *Eusiphonella* (*Scyphia*) *Bronnii*, Goldfuss, sp. ('Petref. Germ.,' vol. i, p. 91, pl. xxxiii, fig. 9), in its mode of branching and the relative thicker walls of the spongites. It may be doubted whether all the forms placed by Quenstedt under *E.* (*Scyphia*) *Bronnii* ('Petref. Deutsch.,' vol. v, p. 183, pl. cxxiv, figs. 1—15) should really be included in a single species; those which are termed *Scyphia Bronnii cæsposa* (l. c., figs. 10—12) approach the nearest to our species.

Distribution.—The form appears to be rare; the only specimen known is from the Great Oolite near Bath, and it is now in the British Natural History Museum.

Genus.—Corynella, *Zittel*.

1878. Studien über fossile Spongien, III. Abhandl. der k. bayer. Akademie der Wiss., Cl. ii, vol. xiii, pt. 2, p. 125.

Sponges simple or compound. The individual forms are club-shaped, cylindrical, or subspherical, with thick walls. Their summits are truncate or arched. Cloacal cavity tubular or funnel-shaped, frequently not extending to the base of the sponge, but passing down into a bundle of vertical canals. The aperture or osculum usually with radiating furrows of open canals. Arched radial canals open into the cloacal cavity. Outer surface usually with small ostia of fine incurrent canals which have a downward oblique direction. Basal portion sometimes with a compact dermal layer. Skeletal fibres of three-rayed spicules; tuning-fork spicules and four-rayed spicules are present in some species.

In outer form the sponges of this genus greatly resemble *Peronidella*, but they are readily distinguished by the development of the canal system. It is doubtful if the Triassic forms included by v. Zittel in this genus possess a similar spicular structure to those from the Jurassic rocks described below.

28. Corynella lycoperdioides, *Lamouroux*, sp. Plate XV, figs. 3—3 *h*.

1821. Halliehoa lycoperdioides, *Lamx.* Exp. méthodique, p. 72, pl. lxxviii, fig. 2.
1840–7. Siphonia lycoperdioides, *Michelin.* Icon. Zoophy., p. 251, pl. lviii, fig. 6.
1878. Corynella lycoperdioides, *Zittel.* Studien, iii, p. 126.
1883. — — *Hinde.* Cat. Foss. Sponges, p. 180.

Sponges simple, depressed globular, pear-shaped, or obtusely conical, rarely corrugate or lobate, supported on a short cylindrical stem, usually attached at its base to a fragment of shell or other organism. Small specimens are not more than 11 mm. in height by 6 mm. in thickness; the body of the largest example met with is 20 mm. in diameter. The stems do not appear to exceed 10 mm. in length.

At the summit the circular oscule slightly projects; it is from 2·8 mm. to 4 mm. in width: in full-grown specimens the rim is entire, but in others short furrows radiate from it; the surface of the sponge is usually smooth, and dotted irregularly with small oval ostia, from ·25 mm. to ·5 mm. in width, which are bounded by the flattened fibres; and in addition to these there are small, irregular,

pore-like openings between the fibres. When the surface is weathered it becomes rough, and occasionally is channelled by open furrows. These ostia and pores are present on the stem as well as on the body of the sponge. The cloacal tube extends down to the stem; its wall is well marked, and perforated at definite intervals by the apertures of the excurrent canals, which are about ·35 mm. in width.

The skeleton consists of a fairly close reticulation of narrow fibres from ·06 mm. to ·18 mm. in thickness, consisting of subequal three-rayed spicules interlaced together (Pl. XV, figs. 3 *d*, 3 *e*). The rays of these are about ·16 mm. in length. In addition to these, delicate tuning-fork spicules can occasionally be seen in the sections, which appear to be arranged nearly parallel with each other on the outer portion of the fibres (Pl. XV, figs. 3 *f*, 3 *g*). In the lower portion of one of the sponges there were bundles of these spicules filling the spaces between the ordinary fibres. One of these forms measured ·17 mm. in length. Within the same sponge there were also several sagittate four-rayed spicules (Pl. XV, fig. 3 *h*) quite distinct from those forming the fibres, and it is possible that these may belong to the wall of the cloacal tube. The only dermal layer in these sponges is a small band round the lower part of the stem.

These sponges are not uncommon in the Bradford Clay and the Cornbrash, and they retain their spicular structure in a very perfect condition.

Distribution.—Bradford Clay at Bradford-on-Avon, Wiltshire, and from the Box Tunnel, Bath. Cornbrash at Langton Herring, near Weymouth. Also from the "Calcaire à Polypiers" at Ranville and Benouville, near Caen, France. All the specimens figured are from the Walton Collection in the Woodwardian Museum, Cambridge.

29. Corynella elegans, *Hinde*, sp. nov. Plate XV, figs. 4—4 *b*.

Sponges simple or compound: the simple forms are round or ovate with a short stem; the compound forms consist of three or four small rounded individuals, sessile on a common base, and usually partially amalgamated with each other. Small simple forms are not more than 6 mm. in height by 5 mm. in diameter, whilst the compound specimens are about 14 mm. in breadth by 7 mm. in height. The surface has small subcircular ostia, ·3 mm. in width, and small irregular apertures between the fibres as well; the summits are rounded, the oscule is 2 mm. in width, its rim does not project above the general surface; the cloacal tube is perforated by elongate canal apertures. The excurrent canals are about ·4 mm. in width. The fibre forms a somewhat open mesh; it varies from ·07 mm.

to ·16 mm. in width. In many respects this species is similar to *C. lycoperdioides;* it is, however, a smaller form, and very frequently compound in its mode of growth.

Distribution.—Great Oolite, Hampton Cliffs, near Bath. (Walton Collection, in the Woodwardian Museum, Cambridge.)

30. Corynella punctata, *Hinde*, sp. nov. Plate XVI, figs. 3—3 *c*.

Sponges simple or in small colonies; the simple individuals are subcylindrical, occasionally nodose, the basal portion usually expanded. In the colonies the spongites are short and frequently amalgamated together to near their summits. A well-marked, compact dermal layer encloses the base and sometimes extends halfway to the summit of the sponge. The oscule is circular, and from 1 mm. to 1·25 mm. in width. The surface of the sponge when not covered by the dermal layer is dotted over by ostial apertures of irregular form, sometimes elongate or substellate, bounded by a very delicate spicular mesh (Pl. XVI, fig. 3 *c*). Smaller pore-like interspaces are present as well as ostia. The cloacal tube is of the same width for at least one-half the length of the sponge. The spicular fibres are delicate, ranging from ·07 mm. to ·14 mm. in thickness; the rays of the axial spicules are ·2 mm. in length by ·04 mm. in thickness. This species appears to be rare; of the four specimens examined the largest simple form is 20 mm. in length by 11 mm. in diameter, whilst a colony of three individuals is 14 mm. in height by 16 mm. in breadth. The characters of the surface serve to distinguish this species from the preceding.

Distribution.—Inferior Oolite. Oolite-Marl, *Murchisonæ*-zone at Ravensgate Hill, near Cheltenham, and Birdlip Hill, Gloucester. (Collected by Mr. R. F. Tomes.)

31. Corynella Langtonensis, *Hinde*, sp. nov. Plate XVI, figs. 2, 2 *a*.

Short subcylindrical sponges, growing directly attached to a shell or some other organism. Length from 20 mm. to 28 mm.; thickness from 18 mm. to 27 mm. Summits gently rounded, the oscular aperture about 6 mm. in breadth; from its rim narrow open furrows, about ·5 mm. wide, extend down the sides. The outer surface has numerous irregularly disposed ostia from ·5 mm. to ·75 mm. in breadth. The fibres, as seen in transverse section, are from ·05 mm. to ·18 mm. in thickness; they resemble in structure the fibres of *C. lycoperdioides*, but I have

failed to recognise in them any tuning-fork spicules. In outer form these sponges resemble some of the specimens included under *Corynella Quenstedti*, Zittel = *Spongites astrophorus*, Quenstedt ('Petref. Deutschl.,' vol. v, p. 208, pl. cxxiv, figs. 58, 59), but the fibres in these latter appear to be of a coarser character than in the present species.

Distribution.—Coral Rag. Zone of *Ammonites plicatilis*, Langton Wold, near Malton, Yorkshire. (Collected by Mr. S. Chadwick.)

32. Corynella Chadwicki, *Hinde*, sp. nov. Plate XV, figs. 6, 6 *a*; Plate XVI, figs. 1—1 *d*.

1816. Elongate alcyonite, *Kendall?* Descriptive Catalogue of the Minerals and Fossil Organic Remains of Scarborough, pt. 3, p. 249, pl. iv, fig. 3.

1848. Scyphia cylindrica, *M'Coy* (non *Goldfuss*). Ann. and Mag. Nat. Hist., s. 2, vol. ii, p. 418.

1854. — — *Morris.* Cat. Brit. Foss., 2nd ed., p. 29.

Sponges usually simple, but occasionally bifurcating or in small colonies of two or three individuals growing from a common base and partially attached laterally. The individual spongites are subcylindrical or club-shaped, straight, curved, or contort, occasionally with nodose swellings, sometimes attached to oysters; their bases are flattened or corrugated, the summits are depressed-conical with a circular oscule, the margin of which is either entire or with a few open furrows extending a short distance down the wall. The dermal layer is limited to a few wrinkled bands crossing the lower portion of the sponge obliquely; in some specimens it is not present at all. The cloacal tube extends to nearly the base of the sponge; it is bounded by a very distinct fibrous wall, and relatively wide canals open into it at irregular intervals (Pl. XVI, fig. 1 *a*). The outer surface of the wall is smooth, with a very delicate meshwork of fibres with small irregular pore-like apertures between them, scarcely visible to the naked eye; definite ostia are absent. The fibres of the interior of the wall are more openly disposed than those of the outer surface or those of the cloacal tube; in cross-section they vary from ·05 mm. to ·16 mm. in thickness, whilst those of the cloacal tube are ·25 mm. in breadth. They consist principally of irregular three-rayed spicules, which are so closely intermingled that only single rays can be made out, and these but seldom for their entire length; the longest rays are ·35 mm. by ·05 mm. in thickness. The larger spicules are in the axial portion of the fibres, and they are enclosed sometimes by a marginal layer of sinuous filiform spicules, but whether

these are simple or three-rayed forms is uncertain. These latter spicules predominate in the wall of the cloaca.

There are considerable differences in the size of the sponges; small specimens are only 15 mm. in length by 7 mm. in thickness, whilst the larger reach to 70 mm. in length and from 10 mm. to 20 mm. in thickness. An example of this species from Malton, now in the Woodwardian Museum at Cambridge, was referred by Prof. M'Coy to *Scyphia cylindrica*, Goldfuss, but independently of the presence of a canal system the fibres of the Yorkshire forms are much more delicate than those in the German sponge. According to Mr. Chadwick, to whom I am indebted for the specimens figured, this species is fairly abundant in the beds of Coralline Oolite which cap Langton Wold for a distance of two or three miles. The specimens are usually simple; not infrequently they are partially covered by a small oyster which has grown over the surface, and sometimes other sponges have also attached themselves to it.

Distribution.—Corallian. Coralline Oolite; zone of *Ammonites plicatilis*, Langton Wold, near Malton. Coral Rag, Settrington, Yorkshire (Coll. Mr. S. Chadwick).

33. Corynella cribrata, *Hinde*, sp. nov. Plate XVI, figs. 4—4*f*.

Sponges rarely simple, usually in small colonies of depressed, subcylindrical, conical, or club-shaped individuals, sometimes completely amalgamated together, in other cases merely connected laterally or else quite free and divergent. The basal portion in some specimens has small patches of wrinkled dermal layer, but as a rule the surface is free and the wall fibres uncovered. The summits of the spongites are sometimes inflated, gently rounded, or conical; the oscule either circular or elliptical, from 1 mm. to 3 mm. in breadth, its margin entire or deeply cleft with open furrows; the walls are deeply traversed by canals—those next the surface forming open furrows—which extend longitudinally, obliquely, or even transversely, and seem to anastomose freely. The larger canals are from ·5 mm. to 1 mm. in breadth, and open into the cloacal tube at irregular intervals. These canals vary in number and direction even in individuals of the same colony; for whilst the surface in some specimens is seamed over with them (Pl. XVI, figs. 4, 4*a*), in others there are but few exposed. As a rule they are more prominent in the smaller specimens. The skeletal fibres are delicate, in transverse section from ·05 mm. to ·18 mm. in thickness. They are mainly composed of irregular three-rayed spicules; one of the rays is usually short and blunt, whilst the other two are more tapering and pointed, ranging from ·16 mm. to ·25 mm. in length. These rays usually overlap one another in

the fibres, and their outlines are very difficult to distinguish in thin sections. Smaller sinuous spicules are present in some of the fibres, but not recognisable in others. In the specimens examined the spicular structure is not well preserved.

There is very great diversity of form and size in the sponges referred to this species, but after careful study of a large series of specimens I feel obliged to unite them together, as in the canal system and in the character of their fibres they are closely similar, and there are numerous transitions between the extremes of the series. The simplest form met with is an ovate specimen, about 10 mm. in length and breadth, growing attached to a fragment of shell. It has a tubular cloaca, and the walls are deeply scored with sinuous furrows (Pl. XVI, fig. 4). In another specimen there are several similar individuals united together into a small colony (fig. 4 *a*), and completely amalgamated; whilst in others the individuals in the colonies may be either partially attached or free from each other except at their bases (figs. 4 *b*—*e*). The largest colony is about 50 mm. in breadth and height, and the spongites from 7 mm. to 9 mm. in diameter. The specimens are for the most part completely weathered out from the matrix, so that the fibres and the canals are shown very distinctly.

Distribution.—Great Oolite. Hampton Cliffs, near Bath. The type-specimens are in the Woodwardian Museum, Cambridge (Walton Collection).

Genus.—Holcospongia,[1] *Hinde*, gen. nov.

Sponges simple or growing in colonies. The individual spongites are spherical, hemispherical, subcylindrical, club-shaped, or discoidal; in the compound forms they are sometimes completely amalgamated with each other. The base of the colony and, in some instances, the lateral surfaces of the spongites are usually covered with a rugose dermal layer. Summits rounded or flattened, with a central area, which may or may not be depressed, in which a variable number of excurrent canals open. From the central area a number of open furrows extend over the summit and down the sides of the sponge, and with these furrows canals from the interior communicate.

The skeleton fibres form an open tissue; they consist of fairly large axial three- and in some instances four-rayed spicules enclosed by marginal filiform spicules, probably three-rayed. The dermal layer consists of an agglomeration of three- and perhaps of four-rayed spicules of various dimensions, which are closely felted together.

[1] Ὀλκός, a furrow.

This genus is proposed for a group of Jurassic and Cretaceous sponges which have hitherto been placed in the genus *Stellispongia*, d'Orbigny ('Prodr. de Pal.,' vol. i, 1849, p. 209). In the type of this genus, *S.* (*Cnemidium*) *variabilis*, Münster ('Beitr. zur Petref.,' vol. iv., 1841, p. 30, pl. i, figs. 21—23), from the Triassic strata of St. Cassian, the fibres have been shown by Steinmann ('Neues Jahrbuch,' 1882, vol. ii. p. 180, pl. ix, fig. 2), and I have myself confirmed his observation, to consist of short, simple, blunted, sinuous spicules of an entirely different character from the spicules forming the fibres in the Jurassic sponges, which, on account of their similarity in growth and in canal structures, have been, by Zittel and other authors, placed under *Stellispongia*. It is, therefore, necessary to place these latter forms in a new genus, and to restrict *Stellispongia* to forms with a spicular structure similar to that of the type species.

The genus *Enaulospongia*, Fromentel ('Mém. Soc. Linn. de Normandie,' vol. xi, p. 48), has also been proposed for a sponge which will come under *Holcospongia*, but v. Zittel has pointed out that the characters assigned to it have been based on the erroneous observation that the sponge is without canals, and it is therefore undesirable to adopt it.

34. Holcospongia floriceps, *Phillips*, sp. Plate XVI, figs. 6—6 *c*; Plate XVII, fig. 2.

1829.	Spongia floriceps,		*Phillips.*	Geol. of Yorks, p. 126, pl. iii, fig. 8.
1854.	—	—	*Morris.*	Cat. Brit. Foss., p. 30.
1860.	—	—	*Wright.*	Quart. Journ. Geol. Soc., vol. xvi, p. 28.
1875.	—	—	*Phillips.*	Geol. of Yorks, 3rd edit., p. 235, pl. iii, fig. 8.
1878.	—	—	*Hudleston.*	Proc. Geol. Assoc., vol. v, pp. 417, 494.
1878.	Peronella floriceps,		*Zittel.*	Studien, Abth. 3, p. 122.
1883.	Stellispongia semicincta et corallina (in part),		*Hinde.*	Cat. Foss. Sponges, p. 187.

Sponges growing in colonies usually from a blunted conical base. Small colonies consist of from three to five individuals, and they are from 20 mm. to 30 mm. in height and thickness, whilst the individuals in large colonies are numerous, and form masses of considerable size, a specimen now in the York Museum measuring 150 mm. in length, 90 mm. in breadth, and 70 mm. in height. The individuals are obtusely conical or subcylindrical, ranging from 10 mm. to 23 mm. in length, and from 8 mm. to 13 mm. in diameter. The summits are conical, rounded, or truncate, without a depressed area; from the centre well-marked, straight, simple, open furrows, from 1 mm. to 1·5 mm. in

width, extend down the sides. The basal portion of the colony has a rugose dermal layer. The canals traversing the sponge are 1·5 mm. in width; they are hardly distinguishable, owing to the open arrangement of the skeletal fibres.

The fibres are relatively very coarse and open in their disposition; they vary between ·15 mm. and ·4 mm. in thickness. The spicules are in such intimate contact that their individual outlines are seldom distinctly shown in thin sections; a single ray of the large axial spicules measures ·46 mm. by ·045 mm. The marginal sinuous spicules are from ·005 mm. to ·01 mm. in thickness.

The distinguishing characters of this species are the truncate-conical form of the individual spongites, the wide well-marked open furrows down their sides, and the coarse character and open structure of the fibres. It grows also in larger masses than any other species of the genus. As a rule the specimens are considerably weathered, so that the surface furrows become obliterated, but it is then recognised by the form of the spongites and the coarseness of the fibres (Pl. XVI, fig. 6 *a*).

Though this species was named and a rude figure of it given by Prof. Phillips in 1829, it does not appear to have been hitherto described. Owing to the imperfect figure, neither generic nor specific characters could be with certainty determined from it, hence Prof. Zittel referred it to the genus *Peronella*, and I had previously placed it with other species of *Stellispongia*. The present description has been based on the type-specimen from the Lower Coral Rag of Hackness, now preserved in the York Museum, and on other specimens from the same locality which have been collected by Mr. S. Chadwick. These specimens are for the most part in a calcareous matrix, which occasionally weathers to a rusty powder, and conspicuously shows the white fibres of the sponge. Sometimes the weathering has acted on the fibres and laid bare their large axial spicules; in one instance the spicule was distinctly four-rayed. The examples from the Lower Calcareous Grit of Filey are enclosed in a granular siliceo-calcareous matrix, and become partially silicified: they are usually smaller than the specimens from the Lower Coral Rag of Suffield, and rarely show the surface furrows; but the character of the fibres is similar, and in all probability they belong to the same species.

From *Holcospongia* (*Spongites*) *glomerata*, Quenstedt, sp., this species differs in its mode of growth, the more prominent surface furrows, and the coarser fibres of the skeleton.

Distribution.—Corallian. Lower Calcareous Grit at Filey Brigg and Scarborough, also in the Lower Limestones or Lower Coral Rag (*Perarmatus*-zone) at Scarborough, Suffield, Hackness, Yorkshire, and in the Coral Rag at Lyneham, Wiltshire.

35. Holcospongia polita, *Hinde*, sp. nov. Plate XVI, figs. 5—5 *e*.

1883. Stellispongia corallina (in part), *Hinde*. Brit. Foss. Sponges, p. 186, pl. xxxv, fig. 3 *a*.

Sponges simple or compound. The simple forms are subspherical, attached either by a small pedicle or directly by the basal surface; they range from 8 mm. to 15 mm. in diameter. The compound specimens grow in irregular compact masses of from three to five individuals, which are usually amalgamated together. The dermal layer is very slightly developed, and when present is limited to the basal portion. The summits have a slight central depression, from which numerous open shallow furrows about ·75 mm. in width radiate down the sides. The radial canals have a similar width to the surface furrows. The fibres have a very open disposition; they vary from ·05 mm. to ·15 mm. in thickness. The rays of the axial spicules range from ·16 mm. to ·43 mm. in length: the marginal filiform spicules are few comparatively, hence the fibres are much more delicate than in the preceding species.

From *Holcospongia floriceps* this species is distinguished by its smaller size, different form, and the more delicate fibres. It more nearly resembles *H. glomerata*, Quenstedt sp., but the fibres are finer.

This species is abundant in the Lower Coral Rag of Suffield and Hackness, in the same beds with *H. floriceps*. The simple spherical forms are more common than the compound ones. Simple forms also occur rarely in the Great Oolite of Hampton Cliffs, near Bath.

Distribution.—Great Oolite, Hampton Cliffs, near Bath (Woodwardian Museum, Cambridge); Lower Coral Rag, *Perarmatus*-zone at Hackness and Suffield, near Scarborough, Yorkshire (Coll. Mr. J. F. Walker, Mr. S. Chadwick); Coral Rag, Lyneham, Wiltshire.

36. Holcospongia glomerata, *Quenstedt*, sp. Plate XVII, figs. 1—1 *c*.

1858. Spongites glomeratus, *Quenstedt*. Der Jura, p. 695, pl. lxxxiv, figs. 10, 11.

1840–47. Cnemidium stellatum, *Michelin* (non *Goldfuss*). Icon. Zooph., p. 115, pl. xxvi, fig. 8.

1878. Spongites glomeratus, *Quenstedt*. Petref. Deutschl., vol. v, p. 223, pl. cxxv, figs. 26—36, 38, 40—54.

1878. Stellispongia glomerata, *Zittel*. Studien, Abth. 3, p. 130.

1878. — — *Hinde*. Cat. Foss. Sponges, p. 187.

Sponges simple or in small irregular masses of three or more individuals. The basal portion flattened, or hollowed out where they have been attached to the convex surfaces of other bodies; the dermal layer limited to the base. The single specimens are rounded or ovate, from 9 mm. to 18 mm. in diameter. The summits usually without a central depression; from the central portion a few deep open furrows radiate; these are about 1 mm. in width. The skeletal fibres measured in a transverse section are from ·1 mm. to ·25 mm. in thickness. The rays of the axial spicules range up to ·46 mm. in length. The filiform spicules are from ·005 mm. to ·01 mm. in thickness; their length could not be ascertained.

To this species I have referred specimens from the Coral Rag of Malton which appear to agree with some of the forms figured by Quenstedt. They differ from *H. polita*, which comes from a slightly lower horizon, in the coarser character and closer arrangement of the skeletal fibres, and in the greater width of their canals; and they are readily distinguishable from *H. floriceps*. The specimens are usually simple forms, and not infrequently they are attached to the surfaces of *Corynella Chadwicki*. (Pl. XVII, fig. 1.)

Distribution.—Corallian. Coralline Oolite; zone of *A. plicatilis*, Langton Wold, Malton; Coral Rag, Settrington, Yorkshire. (Coll. Mr. S. Chadwick.) Also in the Coral Rag at Nattheim.

37. Holcospongia sulcata, *Hinde*, sp. nov. Plate XVII, figs. 3, 3 *a*—*h*.

Sponges simple, forming small fan-shaped, subcircular or ovate, recurved expansions, either directly attached by a small extension of the margin or by a short conical pedicle. Dermal layer slight, restricted to the base and the surface of attachment. The margins are rounded. On the front or upper surface of the sponge several well-marked, straight or curved, simple or furcate, open grooves radiate from a central area, in which there are one or two oscular apertures, but no definite depression. The grooves are from ·75 mm. to 1 mm. in width; they do not extend as a rule to the margins. The spaces between the grooves are occupied by the fibres and the irregular interspaces between them. (Pl. XVII, figs. 3 *a*, 3 *c*, 3 *e*). On the lower or under surface of the sponge there is a series of grooves or furrows radiating fan-like from the point of attachment to the margin which they traverse, and sometimes reach to the upper surface, but they do not regularly connect with the canals of the upper surface. (Pl. XVII, figs. 3, 3 *b*, 3 *d*). These lower grooves are about ·5 mm. in width; they are marked by elongated apertures about 1 mm. in length, which open into the interior of the wall. In young specimens the grooves appear rather as lines of apertures than continuous open furrows.

The skeleton is an open meshwork of fibres; the main lines running between the grooves are ·3 mm. in thickness in transverse section, and the smaller fibres about ·12 mm. The spicular structure is not very distinctly shown; the rays of the larger axial spicules are about ·33 mm. in length by ·08 mm. in thickness. Sinuous marginal spicules are only slightly developed.

These sponges vary considerably in size; small individuals are not more than 5 or 6 mm. in height and breadth, whilst the largest examined is 22 mm., and the average about 12 mm. in height and breadth. The thickness of the wall-plate does not usually exceed 3·5 mm.

This species is very common in the sponge-bed at Shipton Gorge; it is readily distinguished by its mode of growth and the grooved character of the under surface. The specimens are now all free, but they were originally attached to other bodies, and one of the forms shows on its basal expansion an imprint of the cruciform spicules of a Hexactinellid sponge.

Distribution.—Inferior Oolite. *Parkinsoni*-zone at Shipton Gorge, and in the Cliff-section at Burton Bradstock, near Bridport, Dorset. (Mr. E. A. Walford; G. J. Hinde.)

38. Holcospongia contorta, *Hinde*, sp. nov. Plate XVII, figs. 4—4 *d*.

Sponges small, usually simple, but occasionally two individuals are attached at their bases, spherical, hemispherical, or club-shaped, with a flattened or corrugated base. The front surface, and in some forms the summit of the sponge, has from five to six short open grooves or furrows, from ·4 to ·6 mm. in width, radiating star-like from a centre, and bounded by thickened ridges of spicular fibre. These grooves are sometimes contracted to merely oval depressions or oscules, which open into the interior of the wall. The top of the sponge is rounded and sometimes furrowed transversely. The surface opposite to that with the stellate grooves has sometimes slight furrows, or exhibits merely pore-like interspaces between the fibres; not infrequently the entire surface, with the exception of the stellate portion, is covered by a rugose dermal layer, composed of agglomerated three- and four-rayed spicules of various dimensions; the rays of the larger forms, which are very distinctly shown in some parts of the surface, ranging up to ·2 mm. in length, whilst in a small spicule they are not more than ·03 mm. (Pl. XVII, fig. 4 *d*.)

The sponges for the most part are about the size and shape of peas, varying from 3 to 6·5 mm. in diameter. A few exceptional forms are club-shaped, and from 5 to 13 mm. in height. As a rule they are now free, but they appear to have grown by a flattened base on pieces of shell and other organisms. In most of

the specimens the grooves do not radiate from the summit, but from the middle of the front surface. The skeletal fibres are of an open character; they consist mainly of the relatively large axial spicules. The dermal layer has a smooth surface, resembling in appearance the epitheca of corals, but it can be seen to be made up of innumerable three- or perhaps four-rayed spicules of different sizes, irregularly intermingled together, so that the rays overlap each other in all directions.

This species is very abundant in the beds at Shipton Gorge. It is related to *H. sulcata*, but differs in form and size, and in the disposition of the surface furrows.

Distribution.—Inferior Oolite. *Parkinsoni*-zone at Shipton Gorge, Dorset. (Collected by Mr. E. A. Walford.)

39. Holcospongia liasica, *Quenstedt*, sp. Plate XVII, figs. 5—5 *c*.

1878. Spongites liasicus, *Quenstedt*. Petref. Deutschl., vol. v, p. 343, pl. cxxxi, fig. 43.

1883. Myrmecium depressum, *Sollas*. Quart. Journ. Geol. Soc., vol. xxxix, p. 550.

Sponges small, usually simple, though rarely two individuals are attached together; discoidal, with rounded or sharp edges. The under surface may be either flattened, concave, or convex; it is covered by a rugose dermal layer. The upper surface is flattened or convex, with open grooves, simple or furcate, from ·7 to 1 mm. in width, radiating from the central area. The central portion sometimes slightly depressed, with occasional oscules, and in the interspaces between the grooves there are circular canal apertures about ·5 mm. wide. The fibres in transverse section are from ·08 mm. to ·15 mm. in thickness; they consist mainly of robust axial three-rayed spicules. The specimens are from 5 mm. to 9 mm. in width, and from 2·5 mm. to 4·5 mm. in thickness.

In form and surface characters the examples from the Inferior Oolite correspond so closely to the figures given by Quenstedt of a specimen from the Lias near Balingen, that, although unable to compare the minute structure, I think they may be considered to belong to the same species; and, as Prof. Sollas has pointed out, the form described by him from the Great Oolite under the name of *Myrmecium depressum* is equally similar, and may therefore be included as well. As, however, in this specimen there is no tubular cloaca, which according to v. Zittel is one of the essential characters of the genus *Myrmecium*, Goldfuss, it cannot properly be

placed under this genus. The specimens are not uncommon in the Inferior Oolite, but as yet only one has been met with in the Great Oolite.

Distribution.—Inferior Oolite. *Parkinsoni*-zone at Shipton Gorge, near Bridport (Coll. Mr. E. A. Walford). Great Oolite, Hampton Down, near Bath (Coll. Rev. G. F. Whidborne). Also in the Lias near Balingen, Germany (Quenstedt).

40. Holcospongia bella, *Hinde*, sp. nov. Plate XVII, figs. 6—6 *e*.

Sponges small, simple, discoidal, circular in outline, the basal surface either flattened where it has grown on an even surface, or convex with a slight pedicle, and enclosed in a corrugated dermal layer which forms a shallow saucer extending as high as the wall. The upper surface is flattened or slightly raised in the centre, with several well-marked, straight, open grooves, from ·3 mm. to ·5 mm. in width, radiating from the centre or between this and the margin. Between the grooves are slightly raised ridges, on each of which is a row of circular or ovate canal apertures from ·3 mm. to ·5 mm. wide. The skeletal fibres are openly arranged; they vary from ·075 mm. to ·12 mm. in thickness. The fibres show the spicular structure very indistinctly; they are chiefly made up of three-rayed spicules surrounded by smaller filiform spicules.

The specimens are only from 4 mm. to 9 mm. in breadth, and from 1 mm. to 3·5 mm. in thickness. They are now mostly free, but they appear to have grown attached to other organisms; one specimen still remains firmly fixed to a fragment of a Hexactinellid sponge. From *H. liasica* the species is principally distinguished by the regular arrangement of the surface grooves and the canal apertures.

Distribution.—Inferior Oolite. *Parkinsoni*-zone at Shipton Gorge. (Coll. Mr. E. A. Walford.)

41. Holcospongia mitrata, *Hinde*, sp. nov. Plate XVII, figs. 7—7 *d*.

Sponges small, usually simple, but occasionally two are attached together by the dermal layer, depressed conical to subcylindrical, base flattened, covered by a rugose dermal layer, summit conical or rounded, with from three to five deep open grooves from ·6 mm. to 1 mm. in width, which radiate from the centre and extend down the sides. At the centre in some specimens there is a single oscule, but in

others a low ridge crossing the grooves; canals from the interior open into the grooves. The surface of the sponge between the grooves has irregularly scattered oval or circular ostia from ·25 mm. to ·45 mm. in width, as well as pore-like interspaces between the fibres. The spicular structure is similar to that of *H. bella*.

The examples of this species are all very small, varying from 4 mm. to 6 mm. in height and from 3·5 mm. to 7 mm. in thickness. The dermal layer is limited to the base of the sponge; in one specimen it is seen to consist of slender three-rayed spicules: the rays are from ·015 mm. to ·03 mm. in length (Pl. XVII, fig. 7 *d*). The peculiar feature in this species is the manner in which the summit is deeply cleft, so as to give it roughly the appearance of a mitre. The ostia are only seen in the best preserved examples (Pl. XVII, figs. 7, 7 *c*.)

Distribution.—Inferior Oolite. *Parkinsoni*-zone at Shipton Gorge (Mr. E. A. Walford), and from the Marl-bed at Bradford Abbas, Dorset (Mr. R. F. Tomes).

Genus.—Myrmecium, *Goldfuss*.

1826–33. Petrefacta Germaniæ, vol. i, p. 18.

Syn.—Cnemidium, *Goldfuss* (in part); Spongites, *Quenstedt* (in part); Epitheles, *Fromentel* (in part).

Small simple sponges, spherical, hemispherical, or cylindrical, attached by a flattened base or small pedicle; base, and sometimes the lateral surfaces as well, with a corrugated dermal layer. Summit rounded with a central oscule, from which radiating open furrows are given off. A tubular or funnel-shaped cloaca, into which the radial canals open. Outer surface with pore-like ostia. The skeletal fibres delicate. The type species is *Myrmecium hemisphæricum*, Goldfuss, from the Upper Jura of Thurnau ('Petref. Germ.,' vol. i, p. 18, pl. vi, fig. 12).

42. Myrmecium biretiforme, *Sollas*. Plate XVII, fig. 8.

1883. Myrmecium biretiforme, *Sollas*. Quart. Journ. Geol. Soc., vol. xxxix, p. 550.

The type-specimen referred to this species by Prof. Sollas is small, nearly spherical, attached directly by the base; the summit is depressed with a central circular osculum, from which a few inconspicuous open furrows radiate for a short distance. The outer surface exhibits pore-like irregular apertures between the

fibres, with here and there subcircular ostia. The specimen is 10 mm. in breadth by about 7 mm. in height; it has been sectioned horizontally, but the canal structure is not clearly shown. The width of the oscule and the absence of a basal epitheca in this specimen indicate that it does not belong to *Spongites rotula*, var. *biretiformis*, Quenstedt ('Petref. Deutschl.,' vol. v, p. 234, pl. cxxvi, fig. 6), to which it was referred by Prof. Sollas; but as Quenstedt's species really comes under *Myrmecium hemisphæricum*, Goldfuss, the name proposed by Prof. Sollas for the present form will hold good.

Distribution.—Inferior Oolite. *Parkinsoni*-zone in the Cliff at Burton Bradstock, Dorset. (Coll. Rev. G. F. Whidborne.)

Genus.—Lymnorella, *Lamouroux*,[1]—emend., *Hinde*.

1821. Exposition méthodique des genres de l'ordre des Polypiers, p. 77.

Syn.—Mammillopora, *Bronn;* Lymnoreotheles, *Fromentel;* Placorea, *Pomel;* Inobolia, *Hinde*.

Sponges massive, subglobular, irregularly nodose or branching; the individual spongites either completely amalgamated in a common stock, or projecting as conical, subcylindrical, or rounded forms, with tubular cloaca, giving off from the summit oscule short radiating horizontal furrows. In some instances the cloacal tube is not developed, and the spongites are only indicated by slight depressions here and there on the surface, with short open furrows radiating from them, and occasionally even these are not shown. The mode of growth is usually by a succession of concentric layers which overlap each other.

The base of the sponge may be either concave, or there may be a short stout stem. In both cases the base is covered with a rugose dermal layer, which sometimes extends over the lateral surface of the sponge. The surface which is not covered by the dermal layer either consists entirely of irregular pore-like apertures, bounded by the reticulate fibres, or, in addition to these, circular or stellate ostia. The fibres consist of axial three-rayed spicules (possibly also of four-rayed forms as well), enclosed by an outer layer of what is now almost wholly finely fibrous calcite. In this, fragments of filiform spicules and occasionally tuning-fork spicules are present. In one species, in place of the investing calcite layer, the fibres show definite filiform and three-rayed spicules. The typical species is *Lymnorella mamillosa*, Lamx., from the Calcaire à Polypiers (Forest-marble), near Caen.

[1] The name *Lymnorea* having been previously employed in 1809 by Péron et Lesueur for a genus of hydroid zoophytes, I propose to modify the term by using the diminutive "ella," so that it can be retained for these sponges.

There is considerable variation in the characters of the sponges included in this genus. Some massive forms consist of concentric layers of fibrous skeleton with only occasional traces of canals and a few slight depressions of the surface to mark where oscules may have existed, but no further indications of individual spongites are distinguishable in the common stock; whilst in other stocks, conical spongites, each with a tubular cloaca and an open oscule at its summit, project prominently from the mass. These latter correspond with the type-forms of the genus; for those in which canals and oscules are absent or rarely developed I had proposed the genus *Inobolia* (Cat. Foss. Sponges, Brit. Mus., p. 184), but from the study of a large series of specimens it is evident that this genus cannot be maintained independent of *Lymnorella*, since gradational forms occur between the extremes of the series.

The microscopic characters of the skeleton fibres in the sponges of this genus from the Inferior Oolite of this country, and also in some of the examples from the Calcaire à Polypiers, near Caen, exhibit some peculiar features, which may, however, result from the fossilisation. In thin sections the fibres show three-rayed spicules in the central portion, disposed so that the rays slightly overlap each other; they are white by reflected light, but dark granular by transmitted light (Pl. XVIII, figs. 2 *c*, 3 *c*, 6 *b*). These axial spicules are enclosed by a layer of calcite of a lighter tint, which appears to consist of minute crystalline fibres. This outer layer sometimes contains traces of filiform spicules, but as a rule nothing beyond its crystalline structure is present. It is very distinctly marked off from the infilling calcitic or sedimentary matrix (Pl. XVIII, fig. 3 *b*), showing that it is derived from the original skeleton fibre; and it appears to be probably due to a secondary change which has obliterated the smaller spicules in the marginal portion of the fibres, and left the larger axial spicules in their present opaque granular condition. A somewhat similar condition of the skeleton fibres also occurs in *Peronidella tenuis* (Pl. XIV, fig. 2 *a*). In one species, *Lymnorella micula*, from a different horizon and locality, the fibres retain their normal characters (Pl. XVIII, fig. 5 *b*).

43. Lymnorella mamillosa, *Lamx.* Plate XVIII, figs. 2—2 *c*.

1821. Lymnorea mamillosa, *Lamx.* Exp. méthod., p. 77, pl. lxxix, figs. 2—4.
— — *Blainville.* Man. d'Actinologie, p. 541.
1837. Mammillopora mamillosa, *Bronn.* Leth. geogn., vol. i, p. 236.
1878. Lymnorea mammillaris, *Zittel.* Studien, Abth. iii, p. 128.
1883. — mamillosa, *Hinde.* Cat. Foss. Sponges, p. 184, pl. xxxv, figs. 1, 1 *a*, 1 *b*.

Massive sponges, spherical, hemispherical, or irregular in form, supported on a short stout pedicle, or having the under surface concave and covered with a wrinkled dermal layer. The rounded upper surface may be either nearly even or with slightly projecting conical or rounded eminences. The oscules at their summits are about 1 mm. in width, and short open horizontal furrows, about 5 mm. wide, radiate from their margins. The oscules serve as the apertures of straight tubes or cloaca which extend through the sponge, but they are interrupted at intervals by transverse floors, which mark the different layers of growth (Pl. XVIII, fig. 2 *b*). The general surface is covered by numerous subcircular ostia about ·3 mm. in width, bounded by very fine reticulate fibres. The ostia apparently connect with incurrent canals, which, however, cannot be distinguished in the interior of the sponge from the spaces between the skeleton fibres (Pl. XVIII, fig. 2 *a*). The skeleton fibres are delicate, from ·08 mm. to ·16 in thickness: the three-rayed axial spicules are usually in single series; their rays range up to ·24 mm. in length by ·039 mm. in thickness. Tuning-fork spicules are also present.

The sponges are very variable in size; small specimens are not more than 15 mm. in diameter, whilst large forms reach 63 mm. in length by 40 mm. in breadth and height. As a rule the specimens from the Inferior Oolite are larger than those from the "Calcaire à Polypiers" at Ranville, near Caen. The brief description and poor figures of this species given by Lamouroux leave considerable doubt as to its real characters. This author states that the upper surface is "finement lacuneux et sans pores visibles," which seems to imply that there are no ostia, as in the Inferior Oolite specimen here figured (Pl. XVIII, fig. 2). But in some of the examples from the original locality near Caen, now in the British Museum, which otherwise closely correspond with the description of *L. mamillosa*, there are ostia plainly shown; whilst in others not so well preserved, only the fine apertures between the fibres are visible on the surface, and thus the presence of ostia appears to me to be a character of the species.

Distribution.—Inferior Oolite. Pea-grit series; *Murchisonæ*-zone, Crickley Hill, Ravensgate Hill, near Cheltenham (Mr. R. F. Tomes, Mr. F. Longe); cutting on the Midland and South-West Junction Railway, east of Andoversford (Mr. E. Wethered); Oolite-Marl, Birdlip Hill, near Gloucester (Mr. R. F. Tomes). Also in the Calcaire à Polypiers at Les Moustiers, Ranville, Luc, &c., near Caen, France.

44. Lymnorella inclusa, *Hinde*. Plate XVIII, figs. 3—3 *d*.

1883. Inobolia inclusa, *Hinde*. Cat. Foss. Sponges, p. 185, pl. xxxv, figs. 2, 2 *a*, 2 *b*.

Sponges massive, turbinate, subspherical, or in irregular nodose masses.

Base flattened, concave, or with a short stem, and enclosed by a rugose dermal layer, which sometimes also wraps round the sides as well. The upper surface exhibits minute apertures between the fibres, and occasionally small shallow depressions with one or more circular or elongate apertures connected with shallow canals, which appear to represent the oscules; but in some specimens all traces of oscules and distinctive canals have disappeared, and the circulation must have been carried on in the interspaces of the mesh. Vertical sections show concentric zones of growth, which are also marked by bordering bands of the dermal layer on the outside of the sponge.

The skeleton fibres are of a somewhat coarse character; in some portions they are materially thickened: they range from ·12 to ·24 mm. in thickness. The fibres are in the same crystalline condition as in the previous species; in the thickened portions the axial spicules are more numerous and more closely arranged (Pl. XVIII, fig. 3 *c*): the spicular rays range up to ·3 mm. in length by ·036 mm. in thickness. Slender tuning-fork spicules are likewise present in the fibres; a perfect specimen is ·2 mm. in length (Pl. XVIII, fig. 3 *d*). Very minute three-rayed spicules can also be seen in the dermal layer.

There is great difference in the forms of this species. Some examples are nearly round, others top-shaped, whilst others grow in flattened or irregular nodose masses, consisting of successive layers, overlapping each other either partially or entirely. These range from 20 mm. to 80 mm. in thickness. In many no special canals or oscules can be seen, and the genus *Inobolia* was proposed to include these; but there are specimens in which here and there oscular apertures, connected with short open furrows or canals, are developed, thus showing intermediate stages in the canal system, so that no generic distinction can be made on this ground. The distinction between this species and *L. mamillosa* rests on the absence of ostia, the absence or slight development of the canals, and the coarser fibres. It is probably allied to *L. gigantea*, Michelin ('Icon. Zoophy.,' p. 247, pl. lviii, fig. 7), but the description given of this form is insufficient to allow of a definite comparison.

Distribution.—Inferior Oolite. Pea-grit series, Crickley Hill and Cleve Hill, near Cheltenham. Trigonia-grit, Leckhampton (Mr. R. F. Tomes). The type-specimen is in the British Natural History Museum, South Kensington, and there are also specimens in the museums at Jermyn Street and at York.

45. Lymnorella pygmæa, *Sollas*. Plate XVIII, figs. 4—4 *b*.

1883. Limnorea pygmæa, *Sollas*. Quart. Journ. Geol. Soc., vol. xxxix, p. 549, pl. xxi, figs. 29, 30.

Sponges occasionally simple, but usually in small colonies of teat-like or obtusely conical individuals from 5 to 11 mm. in thickness at their bases. The basal portion either with a short thick peduncle or concave; in both cases it is enclosed in a wrinkled dermal layer, which also sometimes envelops the sides of the spongites, leaving their summits free.

The oscule at the summit of the spongites is circular with entire margin, and from 1 to 2 mm. in width. The skeleton fibres vary from ·08 to ·13 mm. in thickness; they are of the same character and in the same condition of preservation as those of *L. mamillosa*.

Of the specimens referred to this species, two are simple forms about 5 mm. in thickness by 8 mm. in height; the others are small masses, the largest of which is 30 mm. in breadth by 20 mm. in height, and the spongites in it are larger than the specimens described by Prof. Sollas, but they appear to be of the same character. The individuals in the colonies are freer and more distinct than in *L. mamillosa*, and in this respect they approach the forms figured by Michelin as *L. mamillosa* ('Icon. Zoophy.,' p. 247, pl. lvii, figs. 10 *a*, 10 *b*), but which appear to me to be distinct from the types of this species.

Distribution.—Inferior Oolite. Pea-grit series, near Cheltenham (Mr. F. Longe); *Parkinsoni*-zone at Shipton Gorge (Mr. E. A. Walford). Great Oolite, Hampton Down, near Bath (Rev. G. F. Whidborne). I have not seen the type-forms of this species, which have been mislaid.

46. Lymnorella ramosa, *Hinde*, sp. nov. Plate XVIII, figs. 6—6 *b*.

Sponges growing in bushy masses of subcylindrical or compressed solid branches springing from a thickened basal stock. The branches dichotomize, and are either obtusely conical or laterally compressed and rounded at their summits, and they show indications of growth by overlapping layers as in *L. inclusa*. No compact dermal layer is present in the specimens yet known. The branches are from 6 to 14 mm. in thickness; they terminate blindly, and are without oscules or axial canals. The surface of the branches is smooth from the exterior fibres being thickened, so that there are only small apertures between them. Scattered

irregularly over the surface are small rosette-like groups of larger apertures about ·5 mm. each, with in some cases short horizontal open furrows radiating from them. There are only traces of canals extending inwards from these larger apertures. The spicular fibres are from ·1 to ·15 mm. in thickness; in transverse section they appear as a labyrinthine reticulation, with the dark axial three-rayed spicules in single series in the centre of the fibres, and the outer portion crystalline as in the species previously described. Fragments of slender filiform spicules can be distinguished, but no tuning-fork spicules have as yet been met with.

The examples of this species are rare, the largest specimen known, which is now in the Jermyn Street Museum, measures 115 mm. in breadth by 110 mm. in height. The mode of growth readily distinguishes this species; in its surface characters it more nearly resembles *L. inclusa*, but the fibres are closer and more delicate.

Distribution.—Inferior Oolite. Pea-grit series, at Crickley Hill and Andoversford, near Cheltenham. (Coll. Mr. R. F. Tomes; Mr. E. Wethered.)

47. Lymnorella micula, *Hinde*. Plate XVIII, figs. 5—5 *d*.

1884. Inobolia micula, *Hinde*. Quart. Journ. Geol. Soc., vol. xl, p. 779, pl. xxxv, figs. 1, 1 *a*—*d*.

Sponges small, occurring as rounded or irregular nodose and somewhat lobate masses, sometimes showing indications of overlapping zones of growth with marginal bands of dermal layer. The base is either rounded or concave, and enclosed in a dermal layer. Some of the specimens show a surface only of smooth fibres with irregular interspaces, and may perhaps be considered as simple sponges; in some of the lobate forms there are faint indications of centres from which some obscurely-marked, open furrows radiate, but there are no oscules or tubular canals. The skeletal fibres are coarse generally, and range from ·14 to ·37 mm. in thickness. They consist of axial three- and perhaps four-rayed spicules, and a definite marginal border of slender filiform spicules, and also of tuning-fork spicules (Pl. XVIII, fig. 5 *b*). The dermal layer consists of three-rayed spicules of various dimensions. The rays of the larger spicules reach a length of ·3 mm. by ·05 mm. in thickness. Some of the tuning-fork spicules are very perfectly shown; in the one figured (Pl. XVIII, fig. 5 *c*) the straight-paired, parallel rays are as long as the unpaired ray. The spicule is ·25 mm. in length.

The sponges range from small—perhaps incomplete—forms not more than 2·5 mm. in thickness to rounded masses 32 mm. in diameter. In its mode of

growth this species resembles *L. inclusa*, but it is much smaller, the fibres are coarser, and there is a great difference in the present structure of the skeleton fibres; this difference, however, probably arises from the fact that in *L. inclusa* the fossilisation has obliterated the smaller spicules and produced the peculiar radiate crystallisation which now characterises them, whereas in this species they retain their normal features.

Distribution.—Great Oolite. Hampton Cliffs, near Bath (Walton Coll., Woodwardian Museum, Cambridge). Also from the well-boring at Richmond, Surrey, at a depth of 1205 feet beneath the surface.

Genus.—Oculospongia, *Fromentel.*

1859. Introduction à l'étude des Éponges fossiles, Mém. de la Soc. Linnéenne de Normandie, vol. xi, No. 2, p. 37.

Syn.—Manon, *Goldfuss* (in part); Oculispongia, Tremospongia, *Roemer* (in part); Sphecidion, *Pomel.*

Sponges rounded, nodose, or club-shaped, massive; the summits with a few scattered circular oscules from which tubular canals or cloaca extend into the body of the sponge; the surface between the oscules with irregular pore-like apertures between the fibres. The base, and frequently the sides of the sponge as well, covered with a dermal layer. The fibres of the skeleton consist of three-rayed spicules in the central portions, with sinuous filiform spicules near the exterior. The type-species is *Oculospongia Neocomiensis*, Fromentel ('Introduction,' p. 37, pl. ii, fig. 8), from the Lower Neocomian at Germigney.

48. Oculospongia minuta, *Hinde.* Plate XIX, figs. 7—7 *b*.

1884. Oculospongia minuta, *Hinde.* Quart. Journ. Geol. Soc., vol. xl, p. 782, pl. xxxv, figs. 5, 5 *a*.

Sponges small, rounded, ovate, or nodose, from 5 to 10 mm. in diameter. Base flattened or concave, with wrinkled dermal layer which sometimes envelops the sides of the sponge, leaving only the upper surface free. The convex upper surface has irregularly scattered, subcircular, oscular apertures, from ·5 to ·75 mm. in width, and between these are the smaller irregular apertures, from ·1 to ·4 mm. in width, of the interstices of the fibres. The skeleton fibres are from ·1 to

·25 mm. in thickness; the rays of the larger three-rayed spicules reach to ·17 mm. in length by ·035 mm. in thickness.

The small sponges included in this species have their oscules and cloacal tubes less prominently developed than in the more typical species of the genus, but they agree better with the characters of *Oculospongia* than with those of any other genus.

Distribution.—Inferior Oolite. *Parkinsoni*-zone at Shipton Gorge, Dorset. (Coll. Mr. E. A. Walford.) Also in the Jurassic beds in the well-boring at Richmond, Surrey, at 1205 feet beneath the surface.

Genus.—Eudea, *Lamouroux.*

1821. Exposition méthodique des genres de l'ordre des Polypiers, p. 46.

Syn.—Verrucospongia, *d'Orbigny* (in part); Epeudea, Ependea, Stegendea, *Fromentel;* Spongites, Orispongia, *Quenstedt;* Solenolmia, Verrucospongia, Elasmeudea, *Pomel.*

Sponges simple or rarely branching; subcylindrical, club-shaped, conical or rounded, with a tubular cloacal cavity opening at the summit and reaching nearly to the base of the sponge. The surface of the sponge, with the exception in some cases of the summit portion, is covered with a thickened dermal layer in which at irregular intervals there are circular or ovate apertures, usually with prominent margins, which open directly into the interspaces between the sponge-fibres. No special canal system beyond that in the interspaces of the fibres. The spicular structure of the fibres very indistinctly shown; three-rayed spicules are present in the central portions of the fibre, and in some instances simple rod-like spicules as well.

The type-species is *Eudea clavata*, Lamx., from the Terrain à Polypiers, near Caen ('Exposition méthodique,' p. 46, pl. lxxiv, figs. 1—4).

49. Eudea Walfordi, *Hinde*, sp. nov. Plate XIX, figs. 1—1 *c*.

Sponges small, simple, subglobular to subcylindrical, attached by a flattened or concave base, the summits truncate or gently rounded, with a central or subcentral oscule about 1 mm. wide with slightly projecting margin. The outer surface usually entirely covered with the dermal layer, but sometimes the summit portion is free and exhibits the fibres. The apertures in the dermal layer are

circular to oval in form, ·6 to 1 mm. in width, with slightly elevated margins; they are irregularly placed, and vary in number in different specimens. In some specimens the skeletal fibres are nearly even with the apertures.

The skeletal fibres are stout; they range from ·08 mm. to ·17 mm. in thickness; the surface layer, and that round the cloacal tube, is specially thickened, and reaches ·25 mm. in transverse section. The spicular structure is very obscurely shown; there are traces of three-rayed spicules and of rod-like forms, which may be portions of tuning-fork spicules, but they are too fragmentary and indefinite to be measured or figured. The specimens range from 3·5 mm. to 6·5 mm. in height, and from 3 mm. to 4·5 mm. in diameter. They are fairly common.

In form this species is nearest allied to *Eudea perforata*, Quenstedt, sp. ('Der Jura,' p. 698, pl. lxxxiv, figs. 26, 27; and 'Petref. Deutschl.,' vol. v, p. 192, pl. cxxiv, figs. 22—28), but it is much smaller, and the skeletal fibres are more delicate. I have named it after Mr. E. A. Walford, F.G.S., who discovered this and the numerous other forms of Calcisponges herein described from Shipton Gorge.

Distribution.—Inferior Oolite. *Parkinsoni*-zone at Shipton Gorge, near Bridport. (Coll. Mr. E. A. Walford.)

50. Eudea pisum, *Quenstedt*, sp. Plate XIX, figs. 2—2*b*.

1878. Orispongia pisum, *Quenstedt*. Petref. Deutschl., vol. v, p. 196, pl. cxxiv, figs. 35, 36.
1878. Eudea pisum, *Zittel*. Studien, Abth. 3, p. 117.

Sponges small, simple, conical or subspherical, sometimes with constrictions of growth, attached either by a narrow or an expanded base, summits conical, with oscule about ·7 mm. wide. Outer surface nearly entirely covered with dermal layer, in which there are circular apertures, about ·5 mm. wide, at the end of short tubular extensions. The specimens range from 5 mm. to 9 mm. in height, and from 3 mm. to 5 mm. in width. The fibres appear to be finer than in *E. Walfordi*, but owing to scarcity of material I have not been able to make sections. This species differs further from *E. Walfordi* in form, in the smaller size of the apertures, and in their tubular extensions.

Distribution.—Inferior Oolite. *Parkinsoni*-zone at Shipton Gorge, Dorset. (Coll. Mr. E. A. Walford.) Also from the Upper or White Jura at Böllert, Balingen, Germany (Quenstedt).

Genus.—Elasmostoma, *Fromentel.*

1859. Introduction à l'étude des Éponges fossiles, Mémoires de la Soc. Linnéennede Normandie, vol. xi, p. 42.

Syn.—Tragos, Manon, Spongia, *Auct.* (in part); Porostoma, Chenendroscyphia, *Fromentel* (in part); Chenendopora, Cupulospongia, *Roemer* (in part); Trachypenia, Coniatopenia, *Pomel.*

Sponges with laminated walls, flattened or convolute; occasionally cup- or funnel-shaped. One surface of the wall is covered with a smooth, compact, or minutely perforate dermal layer, in which are large circular or irregular oscular apertures, which open into the interspaces between the skeletal fibres. The opposite surface is without a dermal layer, and the fibres are uncovered. Skeletal fibres stout, forming an openly reticulate mesh, in which canals, as a rule, are not definitely shown. They consist of large axial three-rayed spicules, enclosed by sinuous filiform spicules; tuning-fork spicules are likewise present in some species, the same as in *Holcospongia.*

The type-species is *E. acutimargo*, Roem., sp. ('Verst. d. Nordd. Oolithgeb. Nachtrag,' p. 10, pl. xvii, fig. 26), from the Neocomian at Berklingen, Brunswick.

51. Elasmostoma palmatum, *Hinde*, sp. nov. Plate XVII, figs. 9—9 *c*; Plate XVIII, figs. 1, 1 *a*.

1854. Spongia helvelloides, *Morris* (*non* Lamx.). Cat. Brit. Foss., 2nd ed., p. 30.

Sponges growing in the form of fan- or ear-shaped plates, variously curved and thickened, attached directly by the margin or by a short blunt pedicle. The walls are from 3·5 mm. to 7 mm. in thickness. The dermal layer covering one surface is compact, with numerous subcircular or irregular oscules from 2 mm. to 3 mm. in width, and usually with elevated margins (Pl. XVIII, fig. 1). Sometimes the oscules are nearly close together, at others about their own diameters apart; they open directly into the interspaces of the fibres beneath. The opposite or non-oscular surface of the sponge has only the irregular spaces between the fibres, which are unusually stout on the exterior (Pl. XVII, fig. 9 *a*). The margins of the wall are rounded.

The skeletal fibres are stout, reticulate, from ·1 mm. to ·5 mm. in thickness; the rays of the axial three-rayed spicules range up to ·26 mm. in length by ·06 mm. in thickness; the smaller sinuous spicules border the fibres, and are interlaced

between the larger spicules (Pl. XVII, fig. 9 *c*). Tuning-fork spicules are present, but it is seldom that they can be recognised in sections. The dermal layer consists of three-rayed spicules closely felted together. Some of these, weathered out on the surface, are as large as the spicules in the fibres (Pl. XVIII, fig. 1 *a*).

The examples of this species vary considerably in form and size; small specimens are 10 mm. in height by 13 mm. in breadth, whilst a large one measures 40 mm. in height by 35 mm. in breadth. The smaller forms are usually fan-shaped; sometimes the walls are flattened, plate-like, with slightly incurved margins; in other instances they are variously contorted, and become thickened and lobed. In many of the specimens the dermal layer is no longer present, and it is very seldom intact even when it has been preserved, and is usually concealed by a growth of small oysters and Serpulæ. The dermal layer appears to be quite distinct from the skeletal fibres, which it covers.

This species is distinguished from the Neocomian species *E. acutimargo*, Roemer, by its thicker walls, and the oscular apertures are much more closely arranged.

Distribution.—Great Oolite. Hampton Cliffs, near Bath. Woodwardian Museum, Cambridge (Walton Collection). Forest Marble at Winsley, near Bath (Mr. E. A. Walford).

Genus.—DIAPLECTIA, *Hinde.*

1883. Cat. Foss. Sponges Brit. Mus., p. 193.

Syn.—Spongia, *Lamx.* (in part); Pharetrospongia, *Zittel* (in part).

Sponges with laminated walls, either cup-, fan-, or platter-shaped. A dermal layer is not developed, and there is no canal system apart from the interspaces of the fibres. The fibres are in some instances disposed longitudinally, in others generally reticulate. The spicular structure consists of axial three-rayed spicules, marginal filiform spicules, and tuning-fork spicules, the same as in *Elasmostoma*, Fromontel.

This genus differs from *Elasmostoma* in the absence of a dermal layer with oscules on one surface. This structure is very liable to disappear in the fossilisation, and Prof. v. Zittel has suggested the probability that sponges similar to those herein included, in which it is now absent, may have been originally covered with this layer. There are, however, numerous well-preserved sponges, such as, for example, those of *Spongia helvelloides*, Lamx., from near Caen, in which not a trace of dermal layer has yet been noticed, and it seems desirable to include such provisionally in a separate genus.

52. Diaplectia auricula, *Hinde*. Plate XIX, figs. 3, 3 *a*.

1883. Diaplectia auricula, *Hinde*. Cat. Foss. Sponges, p. 193, pl. xxxvi, figs. 4, 4 *a*.

Fan- or ear-shaped sponges; the walls from 5 to 10 mm. in thickness with rounded margins. The exterior surface shows a reticular arrangement of the fibres with irregular interspaces. The fibres are very robust, from ·2 to ·4 mm. in thickness; the axial spicules are closely arranged, the marginal spicules have sinuous rays which are dovetailed into each other; occasionally a third ray can be seen in these spicules. Tuning-fork spicules are also present. The only specimen is 30 mm. in height and 50 mm. in breadth.

Distribution.—Inferior Oolite. Pea-grit, near Cheltenham (British Natural History Museum).

53. Diaplectia infundibulum, *Hinde*, sp. nov. Plate XIX, figs. 4, 4 *a*.

Funnel-shaped sponges, walls from 2 to 4 mm. in thickness, the margin rounded. Both the inner and outer surface smooth, the fibres generally reticulate, from ·1 to ·25 mm. in thickness. The interspaces between the fibres irregular, with occasional suboval larger spaces nearly ·5 mm. in width.

Only a single specimen is known, which is 20 mm. in height and 27 mm. in breadth at the summit. In general form it resembles some of the specimens of *Diaplectia helvelloides*, Lamx., sp. ('Exp. méthod.,' p. 87, pl. lxxxiv, figs. 1—3), but the fibres are distinctly finer, and they have not the longitudinal arrangement as in this latter species.

Distribution.—Great Oolite. Bradford, Wiltshire (Woodwardian Museum, Cambridge).

Genus.—Blastinia, *Zittel*.

1878. Studien über fossile Spongien, Abhandl. der k. bayer. Akademie der Wiss., Cl. ii, Bd. xiii, Abth. 3, p. 132.

Syn.—Achilleum, *Goldfuss* (in part); Actinospongia, Pterosmila, *Pomel*; Astrospongia, *Etallon* (in part); Tetrasmila, *Fromentel* (in part).

Sponges simple or compound, subspherical, hemispherical, obtusely conical,

alate, or irregular in form, sessile or with a short pedicle, the base flattened or concave, and with a dermal layer, which in some cases extends over the lower part of the sponge. The upper portion of the sponge is seamed by a series of deeply impressed furrows, which radiate from the summit, and between them are ridges, lobes, or wing-like flanges, which are occasionally laterally corrugated. The sponge is built up of reticulate fibres, which are very thick in the central portions, but slender and open near the exterior. The fibres consist of medium-sized three-rayed spicules, sometimes in a single series or but slightly overlapping each other, but more closely grouped together in the central portion of the flanges or ridges. There is no cloacal tube nor definite canals.

The peculiar form and the absence of a cloacal tube and special canal system readily distinguish this genus. The type-species, *Blastinia* (*Achilleum*) *costata*, Goldfuss, sp., is from the Middle Jura of Streitberg, Würtemberg (' Petref. Germ.,' vol. i, p. 94, pl. xxxiv, fig. 7).

54. Blastinia costata, *Goldfuss*, sp. Plate XIX, figs. 5—5 *c*.

1826—33. Achilleum costatum, *Goldfuss*. Petref. Germ., vol. i, p. 94, pl. xxxiv, fig. 7.
1878. Blastinia costata, *Zittel*. Studien, Abth. 3, p. 132.
1884. — cristata, *Hinde*. Quart. Journ. Geol. Soc., vol. xl, p. 781, pl. xxxv, figs. 3—3 *b*.

Sponges small, simple, hemispherical, depressed-conical or oval in outline, base flattened, or concave when growing on a convex object, with a rugose dermal layer, which in some instances covers the lower portion of the sponge. From the summit a variable number, generally from five to nine, deep depressions extend to near the base, and between these is a corresponding number of rounded ridges. The surface of the ridges merely shows small irregular apertures between the fibres. As seen in a transverse section of the sponge the fibres follow a linear arrangement, radiating from the central area. They are, as a rule, delicate, about ·03 mm. in thickness, but near the ridged portions they become very considerably thickened, and reach ·32 mm. in width. They consist of apparently subequal three-rayed spicules, the rays of which are from ·12 mm. to ·17 mm. in length, and about ·05 mm. in thickness.

The examples of this species are all of small dimensions, ranging from 3 mm. to 7·5 mm. in height, and from 3 to 8 mm. in diameter, and thus they are somewhat smaller than Goldfuss's figured type, which is 10 mm. in height. In the character and number of the ridges our specimens correspond with the type-species, and I do not now see sufficient grounds to regard them as distinct, though from a misunder-

standing as to the real size of the form figured by Goldfuss I previously placed the specimen from the Richmond well-boring as a separate species. I consider, however, that the forms placed in this species by Quenstedt ('Der Jura,' p. 695, pl. lxxxiv, fig. 8; and 'Petref. Deutschl.,' vol. v, p. 221, pl. cxxv, figs. 19—22) are distinct from Goldfuss's type, and probably belong to another species, if not to another genus. The specimen also which I named *Blastinia pygmæa* ('Quart. Journ. Geol. Soc.,' vol. xl, p. 781, pl. xxxv, figs. 4, 4 *a*) seems to me now to be possibly a young form of this or of some other species, and the name should be dropped.

Distribution.—Inferior Oolite, Oolite-Marl, Ravensgate Hill, near Cheltenham. Collected by Mr. R. F. Tomes. Also from the Jurassic beds met with in the well-boring at Richmond, Surrey, at a depth of 1205 feet. Middle beds of the Jura-Kalk at Streitberg (Goldfuss).

55. Blastinia aspera, *Hinde*, sp. nov. Plate XIX, figs. 6—6 *d*.

Sponges simple or compound; the simple forms are conical, pyramidal, hemispherical, and occasionally irregular; the base is flattened or concave according to the surface to which it has been attached; the dermal layer is limited to the base. The ridges or crests are usually sharp-edged, with lateral corrugations; they are separated by wide open depressions, or they stand out as flange-like lobes, from three to six in number, which usually unite at the summit, though in some cases there is a furrow between them above. The specimens vary considerably in form and size; the smallest individual is only 9 mm. in height by 8 mm. in diameter, whilst a compound specimen, in which several conical forms grow on a common base, is 20 mm. in height, 24 mm. in length, and 17 mm. in diameter.

In transverse section the skeleton has the same general arrangement as in *B. costata*,—that is, there are simple delicate fibres, mainly of three-rayed spicules, in a single series near the exterior, whilst in the central portion of the ridges the fibres are unusually thick (Pl. XIX, fig. 6 *c*), ranging from ·4 mm. to 1 mm. in width, though built up of the same kind of spicules as in the more delicate fibres. The rays of the spicules reach up to ·21 mm. in length by ·05 mm. in thickness.

By its larger size, mode of growth, and disposition of the fibres, this species may be distinguished from *B. costata*, Goldfuss, to which it is nearest allied. The specimens do not appear to be uncommon; those which I have seen were all obtained by Mr. S. Chadwick, of Malton.

Distribution.—Coral Rag, *Perarmatus*-zone, at Suffield, near Scarborough, Yorkshire. (Coll. Mr. S. Chadwick.)

Family.—LEUCONES (*Bowerbank*), *Haeckel*.

1872. Die Kalkschwämme, vol. ii, p. 113.

Calcisponges, whose usually thick walls are traversed irregularly by sinuous, branching, often anastomosing canals. The spicules are irregularly distributed in the body of the sponge.

Owing to the loose indefinite arrangement of the skeletal spicules in the sponges of this family they are, as might be supposed, extremely rare as fossils, and the forms from the Middle Lias, described below, are the only representatives known up to the present time in the fossil condition, if we except a few detached spicules occurring in the Upper Chalk and in Pliocene strata.

The chief difference between the Leucones and the Pharetrones, to which all the other Calcisponges herein described belong, consists in the fact that the spicules in this latter family are arranged so as to form solid anastomosing fibres, whereas in the Leucones they are loosely scattered in the soft tissues.

Dunikowski has, however, maintained ('Palæontographica,' vol. xxix, 1883, p. 34) that the fibrous character of the Pharetrones-skeleton is a secondary structure due to the fossilisation, and he has consequently considered the group as only a sub-family of Leucones. The character of the spicules and of the canal system in these families is admittedly very similar, but the markedly distinct fibrous arrangement of the skeleton, which appears to me to be original and not secondary in its nature, justifies, in my opinion, the family distinction assigned by v. Zittel to the Pharetrones as distinct from Leucones.

Genus.—LEUCANDRA, *Haeckel*.

1872. Die Kalkschwämme, vol. ii, p. 170.

Calcisponges with branching canals, in which the skeleton consists of three- and four-rayed spicules as well as simple rod-like forms.

56. LEUCANDRA WALFORDI, *Hinde*. Pl. XIX, figs. 8—8 *x*.

1889. LEUCANDRA WALFORDI, *Hinde*. Ann. and Mag. Nat. Hist., s. 6, vol. iv, p. 352, pl. xvii, figs. 1—9.

Sponges small, club-shaped, subcylindrical or compressed, slightly contracted at the base, which is attached to grains of sand or fragments of other organisms.

The specimens usually occur single, but in some instances two or three individuals are attached together at their bases. They range from 2 mm. to 3·5 mm. in height and from ·6 mm. to 1 mm. in thickness. The outer surface is slightly hispid with obliquely projecting cylindrical or rod-like spicules; the summits are obtusely conical or truncate, without distinctive neck or spicular collar. The cloacal tube extends to nearly the base of the sponge; it opens by a circular or, in the compressed forms, elliptical aperture, from ·2 to ·5 mm. in width (Pl. XIX, fig. 8 *d*). The inner or cloacal surface of the wall is apparently smooth, and, as far as can be seen, without a special spicular layer. The walls of the sponge are about ·2 mm. in thickness; they are composed of cylindrical or fusiform acerates or rods and three- or four-rayed spicules of various dimensions, which for the most part are indiscriminately intermingled together.

The greater number of the simple spicules are nearly straight subcylindrical rods, with styliform slightly inflected ends; they are usually broken; the longest fragments measure ·43 mm. in length by ·005 mm. to ·01 mm. in thickness. Others are straight or slightly curved, fusiform or nearly cylindrical, with acute ends. They range from ·09 to ·29 mm. in length, and from ·0035 mm. to ·007 mm. in thickness (Pl. XIX, figs. 8 *e*—8 *i*). Some of these simple spicules are disposed nearly parallel with or somewhat obliquely to the outer surface, from which their distal ends slightly project. Of the three-rayed spicules (Pl. XIX, figs. 8 *k*—8 *q*) some are regular,—that is, with the rays of equal length; the rays in others appear, however, to be often unequal, but as one or more are usually broken it is not easy to determine how far they may have been similar originally. The rays are smooth, straight, or rarely with a slight curvature, and they gradually taper to an acute point. Sagittate three-rayed forms appear to be absent, but a four-rayed sagittate has been noticed (Pl. XIX, fig. 8 *r*). The spicules vary considerably in size; the rays of a small form are not more than ·03 mm. in length by ·004 mm. in thickness, whilst those of a large spicule measure ·26 mm. in length and ·01 mm. in thickness near the centre. In the four-rayed spicules (Pl. XIX, figs. 8 *r*—8 *u*) the additional apical ray is usually shorter than the three facial rays; in some instances it is more robust, and somewhat abruptly pointed. In cross-section some of the spicular rays are distinctly elliptical.

Very little of the character of the canal system can be ascertained in the wall of this species; there are here and there minute circular apertures visible on the outer surface (Pl. XIX, fig. 8 *a*) which may be apertures of incurrent canals, and traces of winding anastomosing canals are exposed in fractured portions of the wall, whilst indications of the larger excurrent canals are visible on the inner or cloacal surface.

The sponges occur detached and free in a decayed rusty rock, mingled with

sand, oolitic grains, and broken-up fragments of crinoids or other Echinoderms. In outer form some are as perfect as recent specimens, and their spicular structure has been preserved almost unaltered and uninjured in spite of the fact that their constituent spicules are exceedingly slender, fragile, and minute, and that they are only loosely and irregularly intermingled together. The spicules are now somewhat more brittle than those of existing Calcisponges, their surfaces are smooth and without trace of erosion, and they have the same general appearances under the microscope and in polarised light as recent Calcisponge spicules, though they are hardly so lustrous.

Distribution.—Marlstone of the Middle Lias; zone of *Ammonites spinatus*, at King's Sutton, Northamptonshire, associated with Foraminifera, Corals, Mollusca, and Polyzoa. These sponges were discovered by Mr. E. A. Walford, after whom the species is named.

APPENDIX.

TABLE I.—*List of British Jurassic Sponges, zoologically arranged.*

Name of Genus and Species.	Reference to Page and Plate.	Lias.	Inferior Oolite.	Great Oolite.	Oxford Clay.	Corallian.	Kimmeridge.	Portland.	Purbeck.
SILICISPONGIÆ.									
HEXACTINELLIDÆ.									
1. Tremadictyon sparsum, *Hinde*, sp. nov.	P. 195, Pl. X, figs. 1, 1 *a*		×						
2. — incertum, *Hinde*, sp. nov.	P. 196, Pl. X, figs. 2, 4		×						
3. Calathiscus variolatus, *Sollas*	P. 197, Pl. XI, figs. 1, 1 *a*—1 *c*		×						
4. Craticularia clathrata, *Goldfuss*, sp.	P. 198, Pl. XI, fig. 5		×						
5. — foliata, *Quenstedt*, sp.	P. 199, Pl. X, figs. 6, 6 *a*, 6 *b*		×						
6. Verrucocœlia Whidborni, *Sollas*, sp.	P. 200, Pl. XI, figs. 2, 2 *a*		×						
7. — elegans, *Sollas*, sp.	P. 201, Pl. XI, figs. 3, 3 *a*		×						
8. — major, *Sollas*, sp.	P. 201, Pl. XI, fig. 4		×						
9. Stauroderma explanatum, *Hinde*, sp. nov.	P. 202, Pl. X, figs. 5, 5 *a*		×						
LITHISTIDÆ.									
10. Platychonia Brodiei, *Sollas*	P. 204, Pl. XII, figs. 4, 4 *a*	×							
11. — elegans, *Sollas*	P. 204, Pl. XII, figs. 2, 2 *a*, 2 *b*		×						
12. — tenuis, *Hinde*, sp. nov.	P. 205, Pl. XII, figs. 6, 6 *a*		×						
13. — affinis, *Hinde*, sp. nov.	P. 205, Pl. XII, figs. 5, 5 *a*		×						
14. Leiodorella contorta, *Hinde*, sp. nov.	P. 206, Pl. XII, figs. 1, 1 *a*		×						
15. Melonella ovata, *Sollas*, sp.	P. 207, Pl. XIII, figs. 1, 1 *a*—1 *c*		×						
TETRACTINELLIDÆ.									
16. Pachastrella antiqua, *Moore*, sp.	P. 208, Pl. XIII, figs. 3, 4	×						×	
17. Geodites, sp. (*a*)	P. 209, Pl. XIII, fig. 5							×	
18. — sp. (*b*)	P. 210, Pl. XIII, fig. 5 *a*		×						
19. Rhaxella perforata, *Hinde*	P. 210, Pl. XIII, figs. 7, 7 *a*—7 *f*					×			
MONACTINELLIDÆ.									
20. Spongilla Purbeckensis, *Young*	P. 212, Pl. XIII, figs. 6, 6 *a*								×
CALCISPONGIÆ.									
Family PHARETRONES.									
21. Peronidella pistilliformis, *Lamx.*, sp.	P. 213, Pl. XIV, figs. 1, 1 *a*—1 *d*			×					
22. — tenuis, *Hinde*	P. 215, Pl. XIV, figs. 2, 2 *a*		×						
23. — Metabronnii, *Sollas*	P. 215, Pl. XIV, figs. 4, 4 *a*—4 *f*		×						
24. — Waltoni, *Hinde*, sp. nov.	P. 216, Pl. XIV, figs. 3, 3 *a*—3 *c*			×					
25. — recta, *Hinde*, sp. nov.	P. 217, Pl. XV, figs. 1 *a*—1 *c*					×			
26. — nana, *Hinde*	P. 218, Pl. XV, figs. 2, 2 *a*—2 *g*		×	×					
27. Eusiphonella prolifera, *Hinde*, sp. nov.	P. 219, Pl. XV, figs. 5, 5 *a*			×					
28. Corynella lycoperdioides, *Lamx.*, sp.	P. 220, Pl. XV, figs. 3, 3 *a*—3 *h*			×					
29. — elegans, *Hinde*, sp. nov.	P. 221, Pl. XV, figs. 4, 4 *a*, 4 *b*			×					
30. — punctata, *Hinde*, sp. nov.	P. 222, Pl. XVI, figs. 3, 3 *a*—3 *c*		×						
31. — Langtonensis, *Hinde*, sp. nov.	P. 222, Pl. XVI, figs. 2, 2 *a*					×			

Name of Genus and Species.	Reference to Page and Plate.	Lias.	Inferior Oolite.	Great Oolite.	Oxford Clay.	Corallian.	Kimmeridge.	Portland.	Purbeck.
CALCISPONGIÆ (*cont.*).									
32. Corynella Chadwicki, *Hinde*, sp. nov.....	P. 223 { Pl. XV, figs. 6, 6 *a* ..... Pl. XVI, figs. 1, 1 *a*—1 *d* }	...	...	...	...	×			
33. — cribrata, *Hinde*, sp. nov.....	P. 224, Pl. XVI, figs. 4, 4 *a*—4 *f*	...	...	×					
34. Holcospongia floriceps, *Phillips*, sp.	P. 226 { Pl. XVI, figs. 6, 6 *a*—6 *c* Pl. XVII, fig. 2 ..... }	...	...	...	...	×			
35. — polita, *Hinde*, sp. nov.....	P. 228, Pl. XVI, figs. 5, 5 *a*—5 *e*	...	...	×	...	×			
36. — glomerata, *Quenstedt*, sp....	P. 228, Pl. XVII, figs. 1, 1 *a*—1 *c*	...	...	...	...	×			
37. — sulcata, *Hinde*, sp. nov. ...	P. 229, Pl. XVII, figs. 3, 3 *a*—3 *h*	...	×						
38. — contorta, *Hinde*, sp. nov....	P. 230, Pl. XVII, figs. 4, 4 *a*—4 *d*	...	×						
39. — liasica, *Quenstedt*, sp.	P. 231, Pl. XVII. figs. 5, 5 *a*—5 *c*	...	×						
40. — bella, *Hinde*, sp. nov.	P. 232, Pl. XVII, figs. 6, 6 *a*—6 *e*	...	×						
41. — mitrata, *Hinde*, sp. nov. ...	P. 232, Pl. XVII, figs. 7, 7 *a*—7 *d*	...	×						
42. Myrmecium biretiforme, *Sollas*	P. 233, Pl. XVII, fig. 8.....	...	×						
43. Lymnorella mamillosa, *Lamx.*.....	P. 235, Pl. XVIII, figs. 2, 2 *a*—2 *c*	...	×						
44. — inclusa, *Hinde*	P. 236, Pl. XVIII, figs. 3, 3 *a*—3 *d*	...	×						
45. — pygmæa, *Sollas*.....	P. 238, Pl. XVIII, figs. 4, 4 *a*, 4 *b*	...	×	×					
46. — ramosa, *Hinde*, sp. nov.	P. 238, Pl. XVIII, figs. 6, 6 *a*, 6 *b*	...	×						
47. — micula, *Hinde*	P. 239, Pl. XVIII, figs. 5, 5 *a*—5 *d*	...	...	×					
48. Oculospongia minuta, *Hinde*	P. 240, Pl. XIX, figs. 7, 7 *a*, 7 *b*	...	×	×					
49. Eudea Walfordi, *Hinde*, sp. nov.....	P. 241, Pl. XIX, figs. 1, 1 *a*—1 *c*	...	×						
50. — pisum, *Quenstedt*, sp.....	P. 242, Pl. XIX, figs. 2, 2 *a*, 2 *b*	...	×						
51. Elasmostoma palmatum, *Hinde*, sp. nov....	P. 243 { Pl. XVII, figs. 9, 9 *a*—9 *c* Pl. XVIII, figs. 1, 1 *a*... }	...		×					
52. Diaplectia auricula, *Hinde*	P. 245, Pl. XIX, figs. 3, 3 *a*.....	...	×						
53. — infundibulum, *Hinde*, sp. nov.	P. 245, Pl. XIX, figs. 4, 4 *a*.....	...	...	×					
54. Blastinia costata, *Goldfuss*, sp.....	P. 246, Pl. XIX, figs. 5, 5 *a*—5 *c*	...	×	×					
55. — aspera, *Hinde*, sp. nov.....	P. 247, Pl. XIX, figs. 6, 6 *a*—6 *d*	...	...	...	...	×			
Family Leucones.									
56. Leucandra Walfordi, *Hinde*	P. 248, Pl. XIX, figs. 8, 8 *a*—8 *x*	×							

TABLE II.—*List of Fossil Sponges in the Different Divisions of Jurassic Strata.*

LIAS.

Pachastrella antiqua, *Moore*, sp. Lower Lias.

Platychonia Brodiei, *Sollas*. Mid Lias.
Leucandra Walfordi, *Hinde*. „

INFERIOR OOLITE.

Tremadictyon sparsum, *Hinde*. *Parkinsoni-zone*.
— incertum, *Hinde*. „
Calathiscus variolatus, *Sollas*. „
Craticularia clathrata, *Goldfuss*. „
— foliata, *Quenstedt*. „
Verrucocœlia Whidborni, *Sollas*. „
— elegans, *Sollas*. „
— major, *Sollas*. „
Stauroderma explanatum, *Hinde*. „
Platychonia elegans, *Sollas*. „
— tenuis, *Hinde*. „
— affinis, *Hinde*. „
Leiodorella contorta, *Hinde*. „
Melonella ovata, *Sollas*. *Humphresianus-zone*.
Geodites, sp (*b*). *Parkinsoni-zone*.
Peronidella tenuis, *Hinde*. *Murchisonæ-zone*.
— Metabronnii, *Sollas*. *Parkinsoni-zone*.
Peronidella nana, *Hinde*. *Parkinsoni-zone*.
Corynella punctata, *Hinde*. *Murchisonæ-zone*.
Holcospongia sulcata, *Hinde*. *Parkinsoni-zone*.
— contorta, *Hinde*. „
— liasica, *Quenstedt*. „
— bella, *Hinde*. „
— mitrata, *Hinde*. „
Myrmecium biretiforme, *Sollas*. „
Lymnorella mamillosa, *Lamx*. *Murchisonæ-zone*.
— inclusa, *Hinde*. „
— pygmæa, *Sollas*. *Parkinsoni-zone*.
— ramosa, *Hinde*. *Murchisonæ-zone*.
Oculospongia minuta, *Hinde*. *Parkinsoni-zone*.
Eudea Walfordi, *Hinde*. „
— pisum, *Quenstedt*. „
Diaplectia auricula, *Hinde*. *Murchisonæ-zone*.
Blastinia costata, *Goldfuss*. „

GREAT OOLITE.

Peronidella pistilliformis, *Lamx*.
— Waltoni, *Hinde*.
— nana, *Hinde*.
Eusiphonella prolifera, *Hinde*.
Corynella lycoperdioides, *Lamx*.
— elegans, *Hinde*.
— cribrata, *Hinde*.
Holcospongia polita, *Hinde*.
Lymnorella pygmæa, *Sollas*.
— micula, *Hinde*.
Oculospongia minuta, *Hinde*.
Elasmostoma palmatum, *Hinde*.
Diaplectia infundibulum, *Hinde*.
Blastinia costata, *Goldfuss*.

CORALLIAN.

Rhaxella perforata, *Hinde*.
Peronidella recta, *Hinde*.
Corynella Langtonensis, *Hinde*.
— Chadwicki, *Hinde*.
Holcospongia floriceps, *Phillips*.
— polita, *Hinde*.
— glomerata, *Quenstedt*.
Blastinia aspera, *Hinde*.

PORTLAND BEDS.

Pachastrella antiqua, *Moore*.

Geodites, sp. (*a*).

PURBECK BEDS.

Spongilla Purbeckensis, *Young*.

It is somewhat difficult to institute a comparison between the Jurassic sponges in our British area and those from the Palæozoic rocks previously described, since so many of these latter are only known from the isolated spicules, whereas in the majority of the Jurassic sponges, the form and the connected skeletal structures are sufficiently preserved to allow their systematic position to be satisfactorily determined. There can hardly be any doubt, however, that the Tetractinellid genera, *Geodites* and *Pachastrella*, are common to both divisions; but apart from these the Jurassic sponges appear to be generically distinct from the Palæozoic forms. The structure of the Jurassic sponges is, moreover, of the same character as that of their successors in the Cretaceous rocks and in existing seas; there is, further, a marked absence of those peculiar types of spicular structure common in the older rocks.

As regards the Siliceous sponges, the number of genera and species in the British area falls far short of those present in the various zones of the Jurassic "Spongitenkalk" of South Germany and Switzerland; but, on the other hand, the Calcisponges are probably more numerous and varied in the British Jurassic rocks than in those of the Continent.

PLATE X.

Figs. 1, 1 *a*.—Tremadictyon sparsum, *Hinde*, sp. nov. (Page 195.)

Fig. 1.—The upper portion of a large cup-shaped example, showing the inner surface of the wall. Natural size. From the Inferior Oolite, *Parkinsoni*-zone, Burton Bradstock, Dorset. Walton Collection, Woodwardian Museum, Cambridge.

Fig. 1 *a*.—Portion of a thin section of the same taken at right angles to the surface, showing the spicular structure, now replaced by calcite. Enlarged 50 diameters.

Figs. 2, 4.—Tremadictyon incertum, *Hinde*, sp. nov. (Page 196.)

Fig. 2.—Portion of a thin section, showing the spicular structure. Enlarged 50 diameters.

Fig. 4.—A cup-shaped specimen. Natural size. From the Inferior Oolite, *Parkinsoni*-zone, Burton Bradstock. (Collection G. J. Hinde.)

Fig. 3.—Tremadictyon reticulatum, *Goldfuss*, sp. (Page 196.)

A fragment of the spicular mesh of this species, retaining the original siliceous structure. Enlarged 50 diameters. From a specimen from the Upper Jura of Streitberg.

Figs. 5, 5 *a*.—Stauroderma explanatum, *Hinde*, sp. nov. (Page 202.)

Fig. 5.—A fragment of a platter-shaped specimen, showing the oscular apertures of the upper or inner surface of the wall. Natural size. From the Inferior Oolite, *Parkinsoni*-zone, Burton Bradstock. (Collection Rev. G. F. Whidborne).

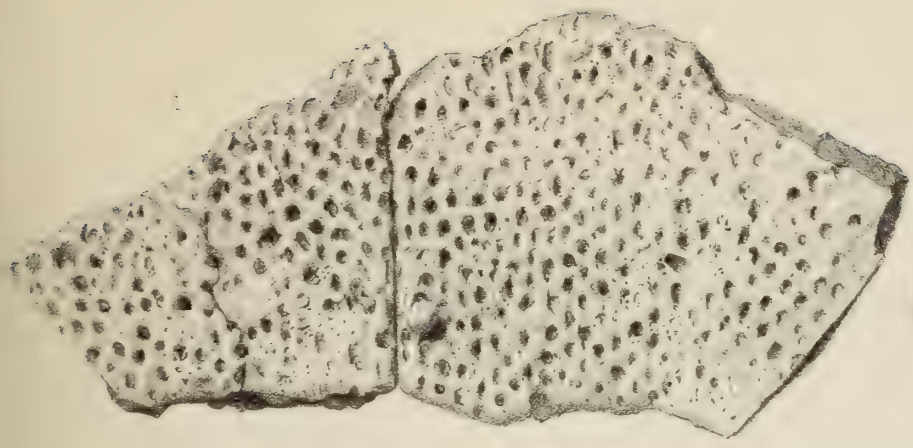
Fig. 5 *a*.—Portion of a transverse section through the wall of the same, showing the spicular structure. Enlarged 50 diameters.

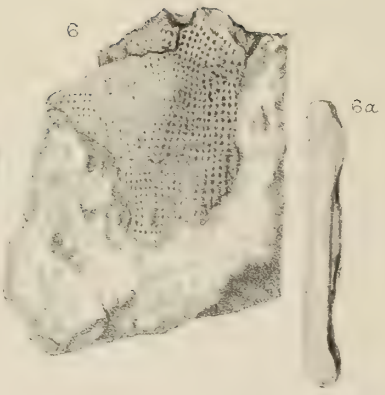
Figs. 6—6 *b*.—Craticularia foliata, *Quenstedt*, sp. (Page 199.)

Fig. 6.—A fragment of the plate-like wall, showing the outer surface. Natural size. From the Inferior Oolite, *Parkinsoni*-zone, at Burton Bradstock. (Collection Rev. G. F. Whidborne.)

Fig. 6 *a*.—Another fragment of the same, showing the thickness of the wall.

Fig. 6 *b*.—Portion of a transverse section of the wall, showing the spicular structure now replaced by calcite. Enlarged 50 diameters.

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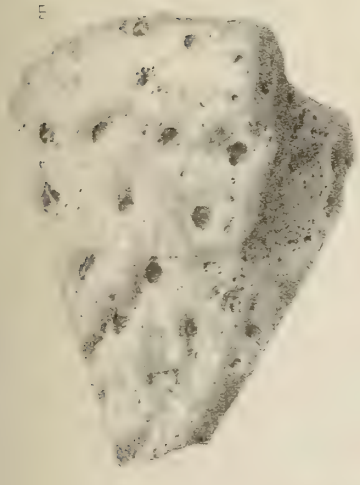
6a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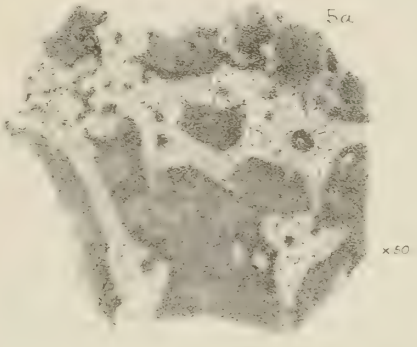
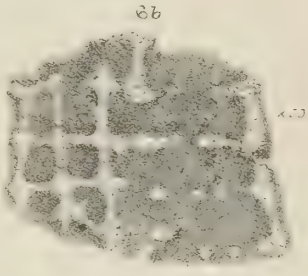

5a
×50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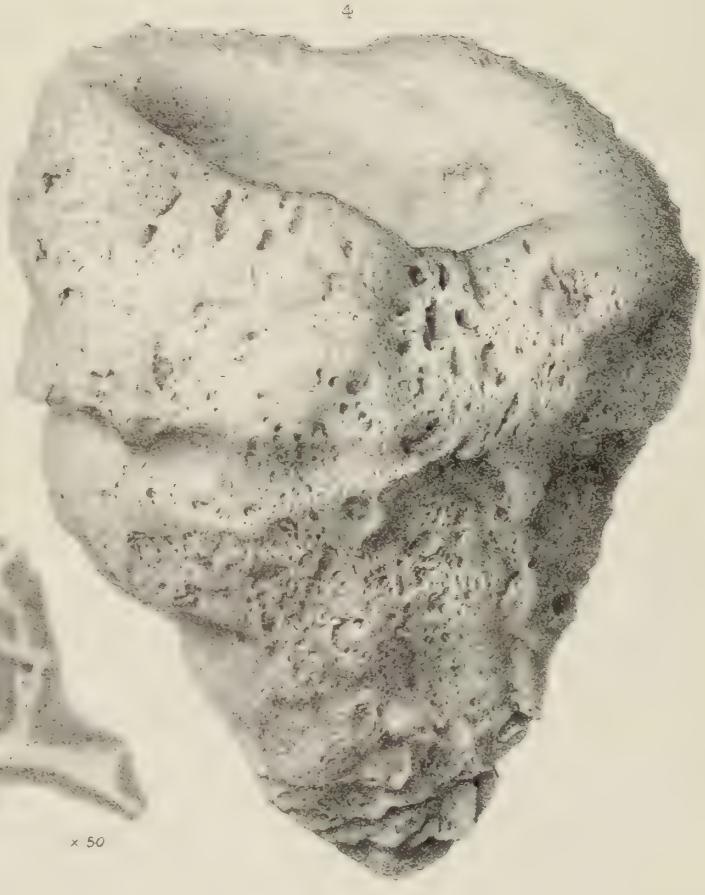
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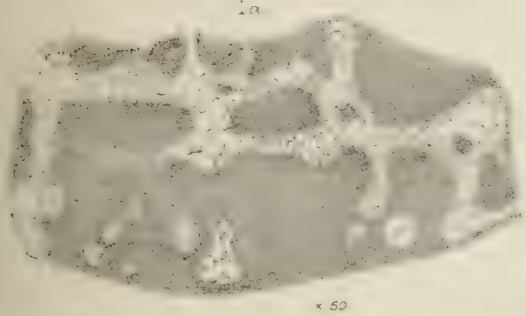
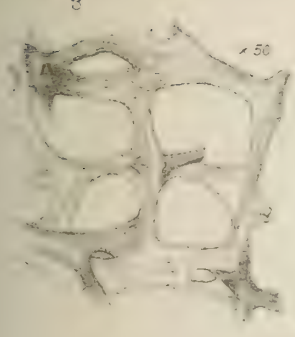

1a
× 50


3
× 50

2
× 50

PLATE XI.

Figs. 1—1 *c*.—Calathiscus variolatus, *Sollas*. (Page 197.)

Fig. 1.—A nearly complete specimen, showing the character of the outer surface, somewhat injured by weathering. Natural size. From the Inferior Oolite, *Parkinsoni*-zone, at Burton Bradstock. The type of the species. (Collection Rev. G. F. Whidborne.)

Fig. 1 *a*.—The imperfect upper portion of another specimen from the same place, showing traces of the apertures on the inner surface of the wall. Natural size. (Collection Rev. G. F. Whidborne.)

Figs. 1 *b*, 1 *c*.—Portions of sections of the sponge-wall, showing the spicular structure, now replaced by calcite. Enlarged 50 diameters.

Figs. 2, 2 *a*.—Verrucocœlia Whidborni, *Sollas*, sp. (Page 200.)

Fig. 2.—A nearly complete specimen, showing the upper surface. Natural size. From the Inferior Oolite, *Parkinsoni*-zone, Burton Bradstock. The type of the species. (Collection Rev. G. F. Whidborne.)

Fig. 2 *a*.—Portion of a section of the wall, showing the spicular structure. Enlarged 50 diameters.

Figs. 3, 3 *a*.—Verrucocœlia elegans, *Sollas*, sp. (Page 201.)

Fig. 3.—The type of the species. Natural size. From the Inferior Oolite, *Parkinsoni*-zone, Burton Bradstock. (Collection Rev. G. F. Whidborne.)

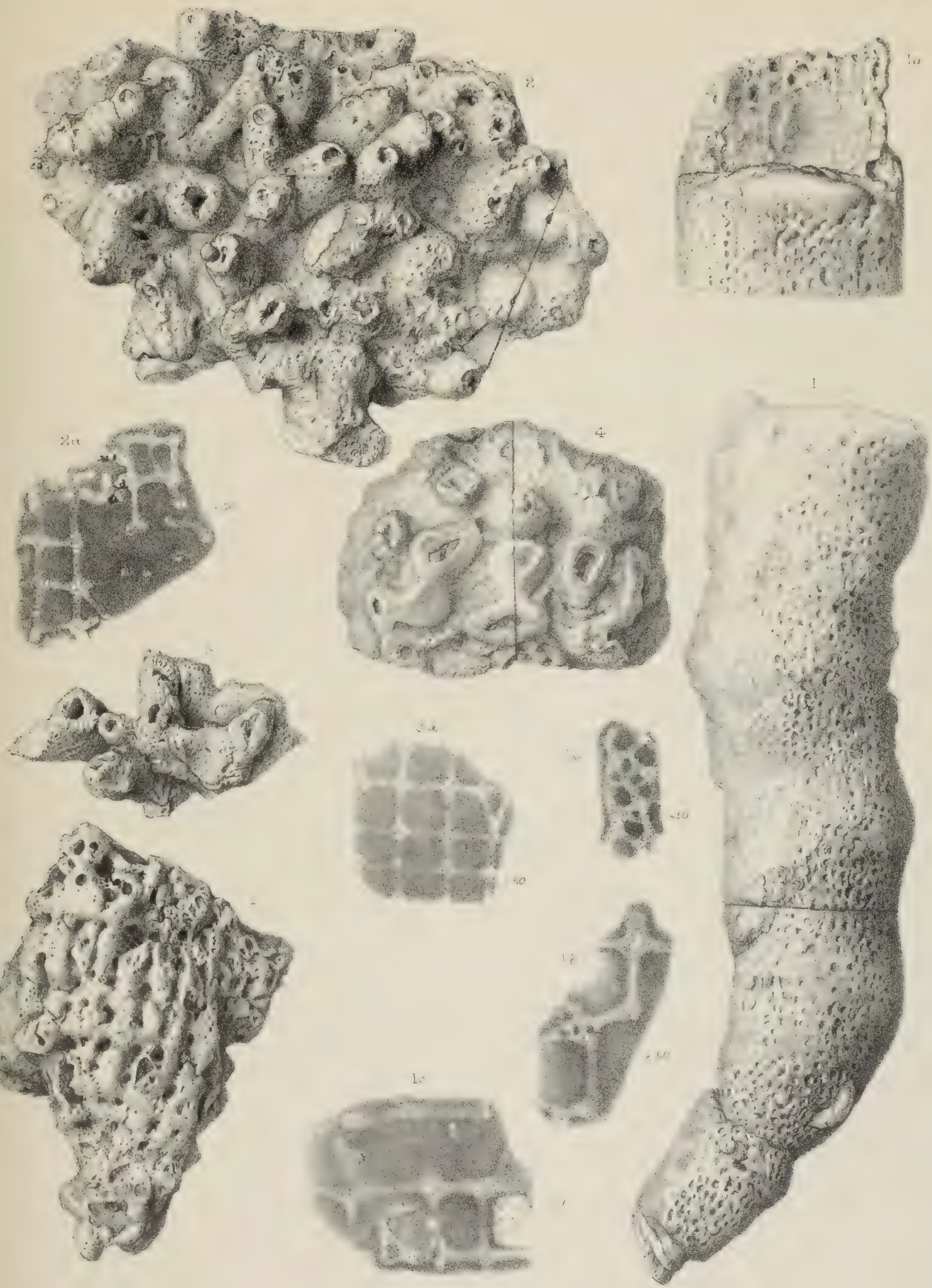
Fig. 3 *a*.—A portion of the sponge wall, showing the spicular structure. Enlarged 50 diameters.

Fig. 4.—Verrucocœlia major, *Sollas*, sp. (Page 201.)

The type of the species, showing the summits of the spongites weathered out on the surface of a limestone nodule. Natural size. From the Inferior Oolite, *Parkinsoni*-zone, at Burton Bradstock. (Collection Rev. G. F. Whidborne.)

Fig. 5.—Craticularia clathrata, *Goldfuss*, sp. (Page 198.)

An incomplete specimen, showing the characters of the outer surface, but partially obscured by weathering. Natural size. Inferior Oolite, *Parkinsoni*-zone, at Burton Bradstock. Walton Collection, Woodwardian Museum, Cambridge.



A.T. Hollick del. et lith.

JURASSIC SPONGES

West, Newman imp.

PLATE XII.

Figs. 1, 1 *a*.—Leiodorella contorta, *Hinde*, sp. nov. (Page 206.)

Fig. 1.—A specimen showing the outer surface of the wall with the oscules, now enlarged by weathering. Natural size. From the Inferior Oolite, *Parkinsoni*-zone, at Burton Bradstock. (Collection G. J. Hinde.)

Fig. 1 *a*.—Portion of a transverse section of the sponge, showing the spicular structure, now replaced by calcite. Enlarged 20 diameters.

Figs. 2—2 *b*.—Platychonia elegans, *Sollas*. (Page 204.)

Fig. 2.—A nearly complete specimen, growing attached to the surface of *Calathiscus variolatus*, showing the reticulation of the upper surface of the wall. Natural size. From the Inferior Oolite, *Parkinsoni*-zone, at Burton Bradstock. (Collection G. J. Hinde.)

Fig. 2 *a*.—Another specimen from the same locality, showing the under surface. (Collection Rev. G. F. Whidborne.)

Fig. 2 *b*.—Portion of a transverse section, showing the spicular structure. Enlarged 50 diameters.

Fig. 3.—Platychonia vagans, *Quenstedt*, sp. (Page 205.)

A small fragment of the spicular mesh of this species, showing the spicules in their original siliceous condition. Enlarged 50 diameters. Figured for comparison with the preceding. The sponge is from the Upper or White Jura of Streitberg, Germany.

Figs. 4, 4 *a*.—Platychonia Brodiei, *Sollas*. (Page 204.)

Fig. 4.—The type-specimen. Natural size. From the Marlstone of the Middle Lias, Ilminster, Somerset. (Collection Rev. P. B. Brodie.)

Fig. 4 *a*.—A median section of the same, showing the thickness of the wall. This figure and the preceding are copied from the figures given by Sollas in 'Proc. Roy. Dubl. Soc.,' N. S., vol. xli, pl. xxi.

Figs. 5, 5 *a*.—Platychonia affinis, *Hinde*, sp. nov. (Page 205.)

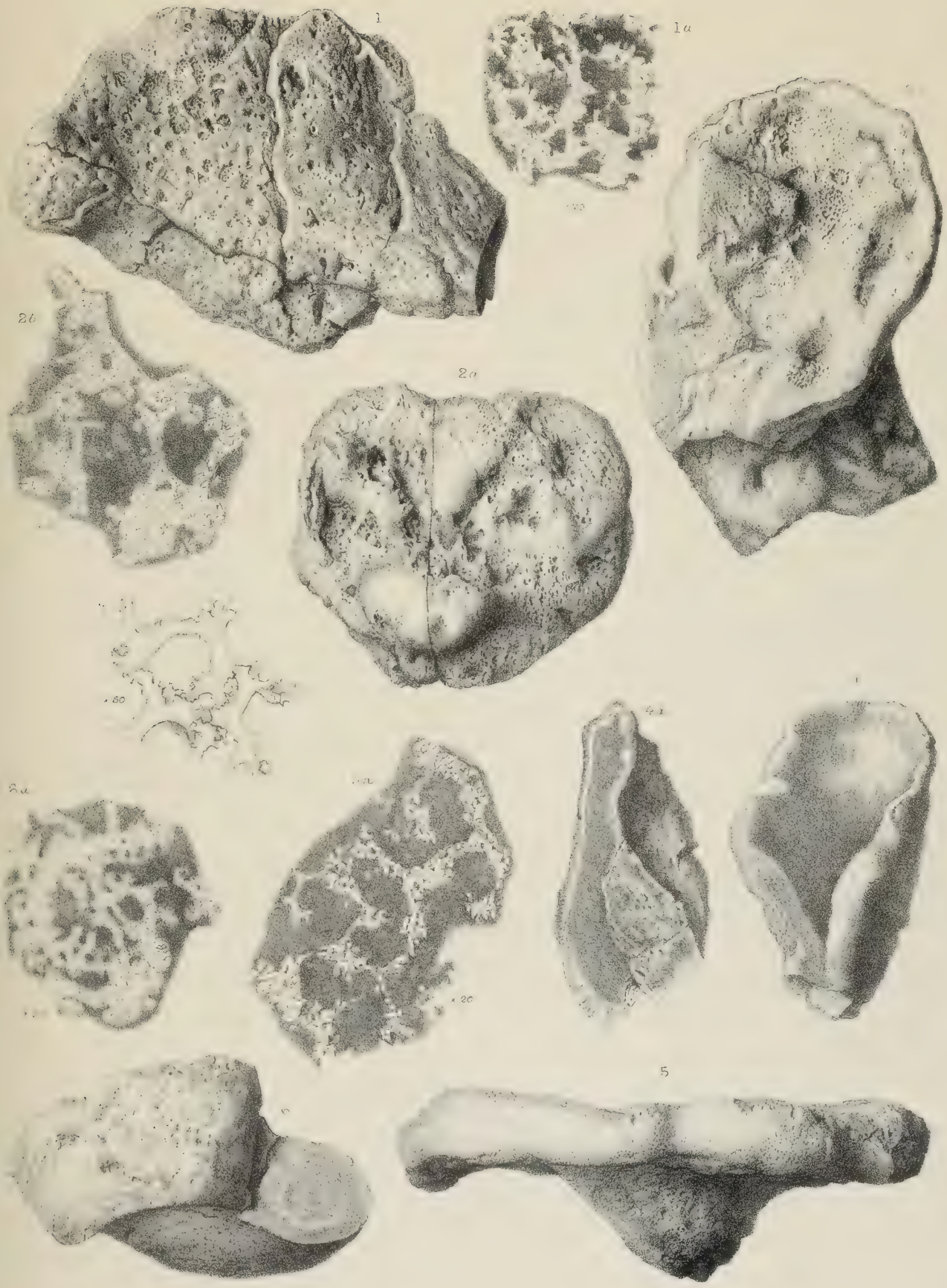
Fig. 5.—The type-specimen. Natural size. Inferior Oolite, *Parkinsoni*-zone, Burton Bradstock. (Collection G. J. Hinde.)

Fig. 5 *a*.—A portion of a transverse section, showing the spicular structure now replaced by calcite. Enlarged 20 diameters.

Figs. 6, 6 *a*.—Platychonia tenuis, *Hinde*, sp. nov. (Page 205.)

Fig. 6.—A convolute specimen. Natural size. The wall on the right of the specimen has been cut through to show its thickness. Inferior Oolite, *Parkinsoni*-zone, at Burton Bradstock. (Collection G. J. Hinde.)

Fig. 6 *a*.—A portion of a section, showing the spicular structure now replaced by calcite. Enlarged 50 diameters.



A T Hollick del et lith.

JURASSIC SPONGES

West, Newman imp.

PLATE XIII.

Figs. 1—1 *c*.—Melonella ovata, *Sollas*, sp. (Page 207.)

Figs. 1, 1 *a*.—The type-forms of the species. Natural size. Inferior Oolite, *Humphresianus*-zone, at Dundry Hill, near Bristol. (Collection Rev. G. F. Whidborne.)

Fig. 1 *b*.—A portion of a vertical median section of one of the specimens, showing the spicular structure, now replaced by calcite. Enlarged 50 diameters.

Fig. 1 *c*.—A portion of the surface of 1 *a*, showing the weathered-out spicular nodes. Enlarged 50 diameters.

Figs. 2, 2 *a*.—Cylindrophyma milleporatum, *Goldfuss*, sp. (Page 208.)

Detached siliceous spicules of this species. Enlarged 50 diameters. From the Upper White Jura of Beuren, Germany. Figured for comparison with the preceding.

Figs. 3, 4.—Pachastrella antiqua, *Moore*, sp. (Page 208.)

Fig. 3.—Detached caltrop spicules of this species. Enlarged 20 diameters. From chert in the Portland Beds, Isle of Portland. Museum of the Geological Survey, Jermyn Street.

Fig. 4.—A section of Lower Lias Limestone, showing spicules of this species intermingled with others, all of them now replaced by calcite. Enlarged 20 diameters. Lower Lias, Shepton Mallet, Somersetshire.

Fig. 5.—Geodites, sp. (*a*). (Page 209.)

An imperfect trifid spicule. Enlarged 20 diameters. From the cherty bands in the Portland Limestone, Isle of Portland.

Fig. 5 *a*.—Geodites, sp. (*b*). (Page 210.)

An imperfect trifid and a simple acerate spicule, probably belonging to the same species. Inferior Oolite, *Parkinsoni*-zone, at Burton Bradstock.

Figs. 6, 6 *a*.—Spongilla Purbeckensis, *Young*. (Page 212.)

Fig. 6.—A section of chert filled with the spicules of this species. Enlarged 50 diameters. From the Purbeck Limestones at Stare Cove, Lulworth, Dorsetshire.

Fig. 6 *a*.—Longitudinal, oblique, and transverse sections of some of the spicules. Enlarged 100 diameters.

Figs. 7—7 *f*.—Rhaxella perforata, *Hinde*. (Page 210.)

Fig. 7.—An imperfect specimen, partially weathered out of a slab of rock. Natural size. From the Lower Calcareous Grit, Scarborough, Yorkshire. York Museum.

Fig. 7 *a*.—A fragment of another specimen, showing the slit-like apertures in the wall. Natural size.

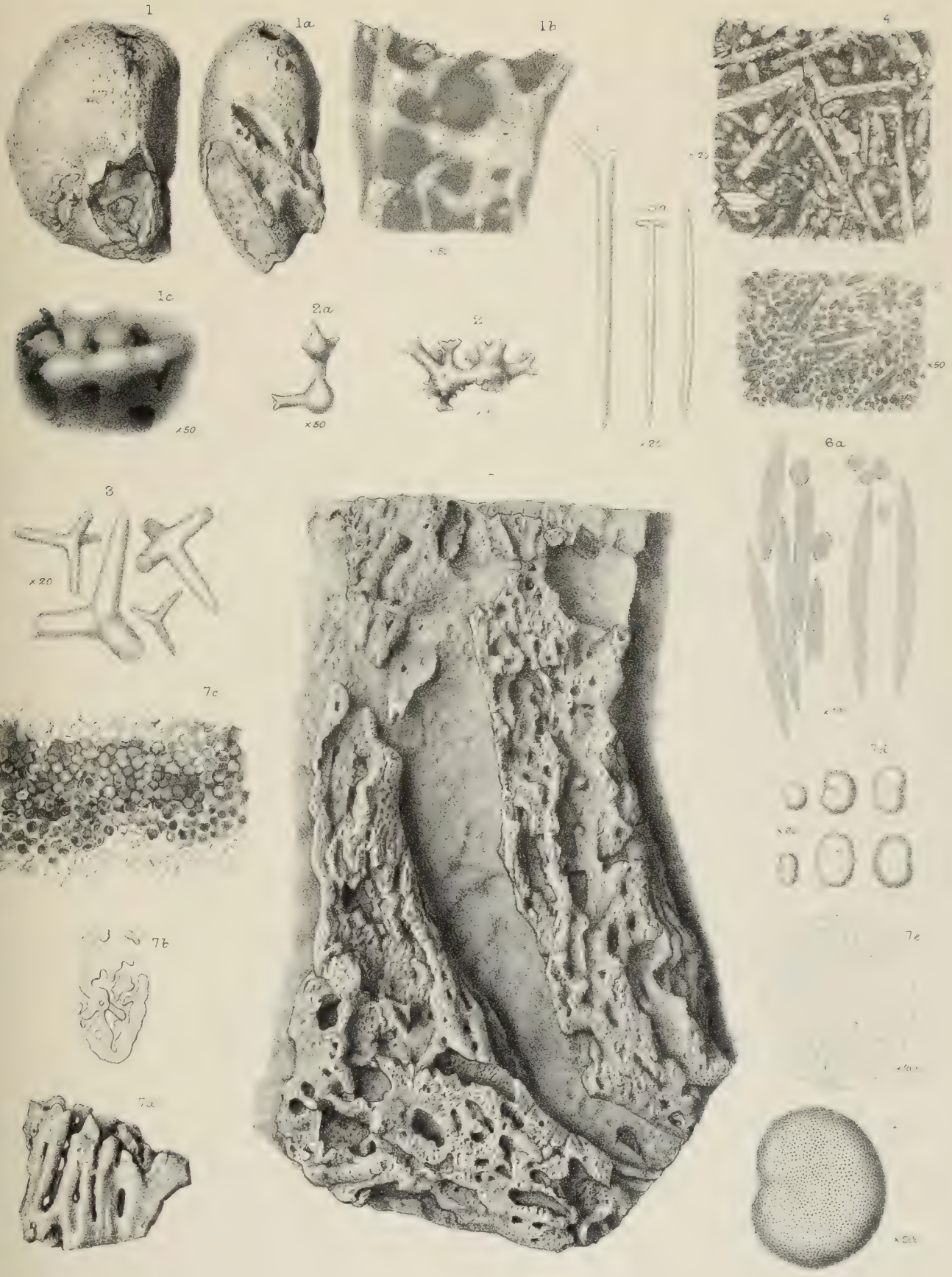
Fig. 7 *b*.—A transverse section of the same piece, showing the disposition of the wall-laminæ. Natural size.

Fig. 7 *c*.—A thin section of a fragment of the wall, showing its composition of globate spicules. Enlarged 20 diameters.

Fig. 7 *d*.—Some of the detached spicules, showing variations in form and size.

Fig. 7 *e*.—A single spicule, mounted in glycerine, showing traces of its component rods. Enlarged 200 diameters.

Fig. 7 *f*.—Another spcule, similarly enlarged, showing the surface structure.



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JURASSIC SPONGES.

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PLATE XIV.

Figs. 1—1 *d.*—Peronidella pistilliformis, *Lamouroux*, sp. (Page 213.)

Figs. 1—1 *b.*—Three separate colonies, showing variations in the mode of growth, and in the size and disposition of the individual spongites. Natural size. All from the Great Oolite at Hampton Cliffs, near Bath. Woodwardian Museum, Cambridge (Walton Collection).

Fig. 1 *c.*—Part of a transverse section of the sponge-wall, showing the spicular structure of the fibres. Enlarged 60 diameters.

Fig. 1 *d.*—Two tuning-fork spicules, imperfect, seen in the fibres of the same section. Enlarged 200 diameters.

Figs. 2, 2 *a.*—Peronidella tenuis, *Hinde.* (Page 215.)

Fig. 2.—The type of the species. Natural size. Inferior Oolite, Pea-grit, zone of *Ammonites Murchisonæ*, near Cheltenham. British Natural History Museum.

Fig. 2 *a.*—Part of a transverse section; only traces of three-rayed spicules surrounded by crystalline fibres are shown. Enlarged 60 diameters.

Figs. 3—3 *c.*—Peronidella Waltoni, *Hinde*, sp. nov. (Page 216.)

Fig. 3.—An imperfect specimen, in which a lateral branch grows parallel with the main stem. Natural size.

Fig. 3 *a.*—An imperfect specimen, in which four divergent stems grow from a common centre. Natural size.

Fig. 3 *b.*—An imperfect specimen in which several stumpy branches grow from the main stems. The surface in this specimen is partly smooth, with small perforations. Natural size. All these specimens are from the Great Oolite, Hampton Cliffs, near Bath, and they belong to the Walton Collection in the Woodwardian Museum, Cambridge.

Fig. 3 *c.*—A transverse section of the sponge-wall from the exterior to the cloacal tube, showing the disposition of the fibres. Enlarged 10 diameters.

Figs. 4—4 *f.*—Peronidella Metabronnii, *Sollas.* (Page 215.)

Figs. 4—4 *b.*—Three specimens, showing variations in form and mode of growth. Natural size. In fig. 4 a young specimen of the same species has attached itself to the surface of the larger, and in 4 *b* a small specimen of *Holcospongia bella* has fixed itself for support. The forms are all from the Inferior Oolite, *Parkinsoni*-zone, at Shipton Gorge, near Bridport, Dorset. Collection E. A. Walford.

Fig. 4 *c.*—A vertical median section, showing the thickness of the wall, the form of the cloaca, the lower portion of which is filled by matrix, and the pores in its walls. Natural size.

Fig. 4 *d.*—A portion of the outer surface of the sponge showing the disposition of the fibres. Enlarged 10 diameters.

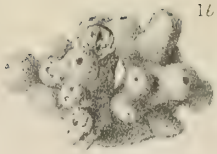
Fig. 4 *e.*—A portion of the wall of the cloaca showing the regular oval perforations. Enlarged 10 diameters.

Fig. 4 *f.*—A portion of a transverse section of the wall showing the fibres. Enlarged 60 diameters. The spicular structure is nearly wholly obliterated.

1

1a

1d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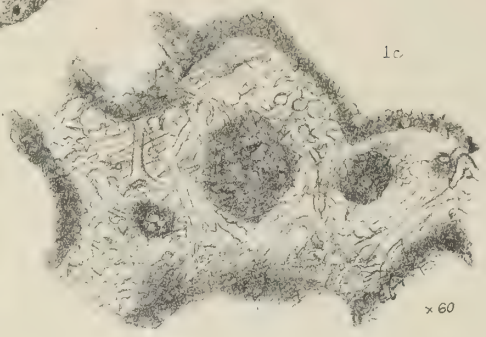
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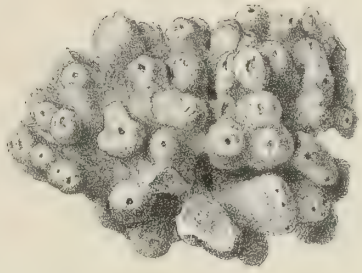
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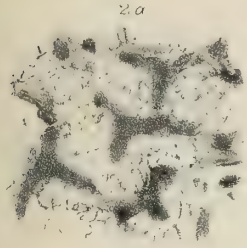
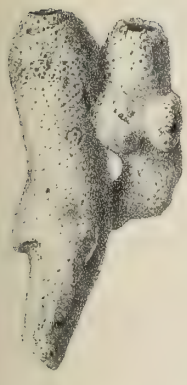

2a

×60

4b

4a

4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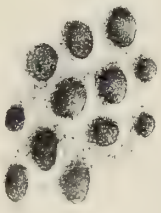
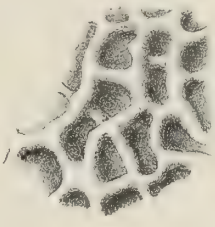
4f

×60


4e

×10

4c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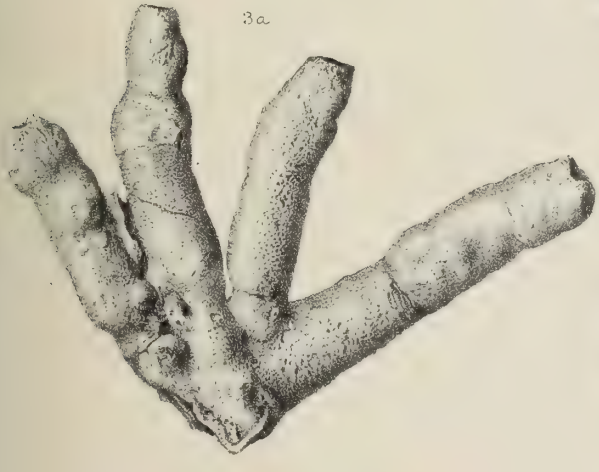
3b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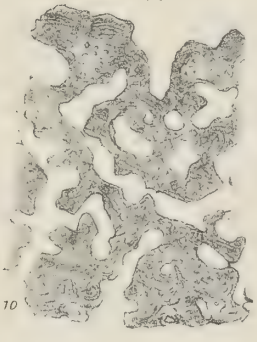
3c

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JURASSIC SPONGES

PLATE XV.

Figs. 1—1 *c*.—Peronidella recta, *Hinde*, sp. nov. (Page 217.)

Figs. 1, 1 *a*.—Two of the compound forms, natural size. The transverse groove in fig. 1 is the impress of an Echinoderm spine to which the sponge has been attached. From the Lower Calcareous Grit at Suffield, near Scarborough. (Coll. Mr. S. Chadwick.)

Fig. 1 *b*.—A portion of the outer surface, showing the interspaces between the fibres. Enlarged 10 diameters.

Fig. 1 *c*.—A portion of a transverse section showing the fibres and traces of three-rayed spicules. Enlarged 60 diameters.

Figs. 2—2 *g*.—Peronidella nana, *Hinde*. (Page 218.)

Figs. 2, 2 *a*.—A specimen, natural size, and enlarged 4 diameters.

Figs. 2 *b*—2 *e*.—Different specimens, showing variations in form and size. Inferior Oolite, *Parkinsoni*-zone, at Shipton Gorge, Dorset. (Coll. Mr. E. A. Walford.)

Fig. 2 *f*.—A portion of the outer surface showing the irregular interspaces between the fibres. Enlarged 10 diameters.

Fig. 2 *g*.—A portion of a section showing the fibres; the spicular structure has been obliterated. Enlarged 60 diameters.

Figs. 3—3 *h*.—Corynella lycoperdioides, *Lamx*., sp. (Page 220.)

Figs. 3—3 *c*.—Four specimens of the sponge. Natural size. Fig. 3 *a* is partially lobate, and the stem is wanting; in fig. 3 *b* the stem has also been partially broken off. All the specimens are from the Cornbrash at Langton Herring near Weymouth, and they belong to the Woodwardian Museum at Cambridge.

Figs. 3 *d*, 3 *e*.—Portions of transverse and longitudinal sections, showing the disposition and the spicular structure of the fibres. Enlarged 60 diameters.

Figs. 3 *f*, 3 *g*.—Tuning-fork spicules; in fig. 3 *f* as seen in their natural position in the fibres. Fig. 3 *g* is a single spicule, imperfect, from the same microscopic section. Enlarged 200 diameters.

Fig. 3 *h*.—A sagittate four-rayed spicule from the same sponge. Enlarged 100 diameters.

Figs. 4—4 *b*.—Corynella elegans, *Hinde*, sp. nov. (Page 221.)

Figs. 4, 4 *a*.—A simple individual and a compound specimen. Natural size. From the Great Oolite at Hampton Cliffs, near Bath. Woodwardian Museum, Cambridge, Walton Collection.

Fig. 4 *b*.—A portion of a transverse section, showing the spicular structure of the fibres. Enlarged 60 diameters.

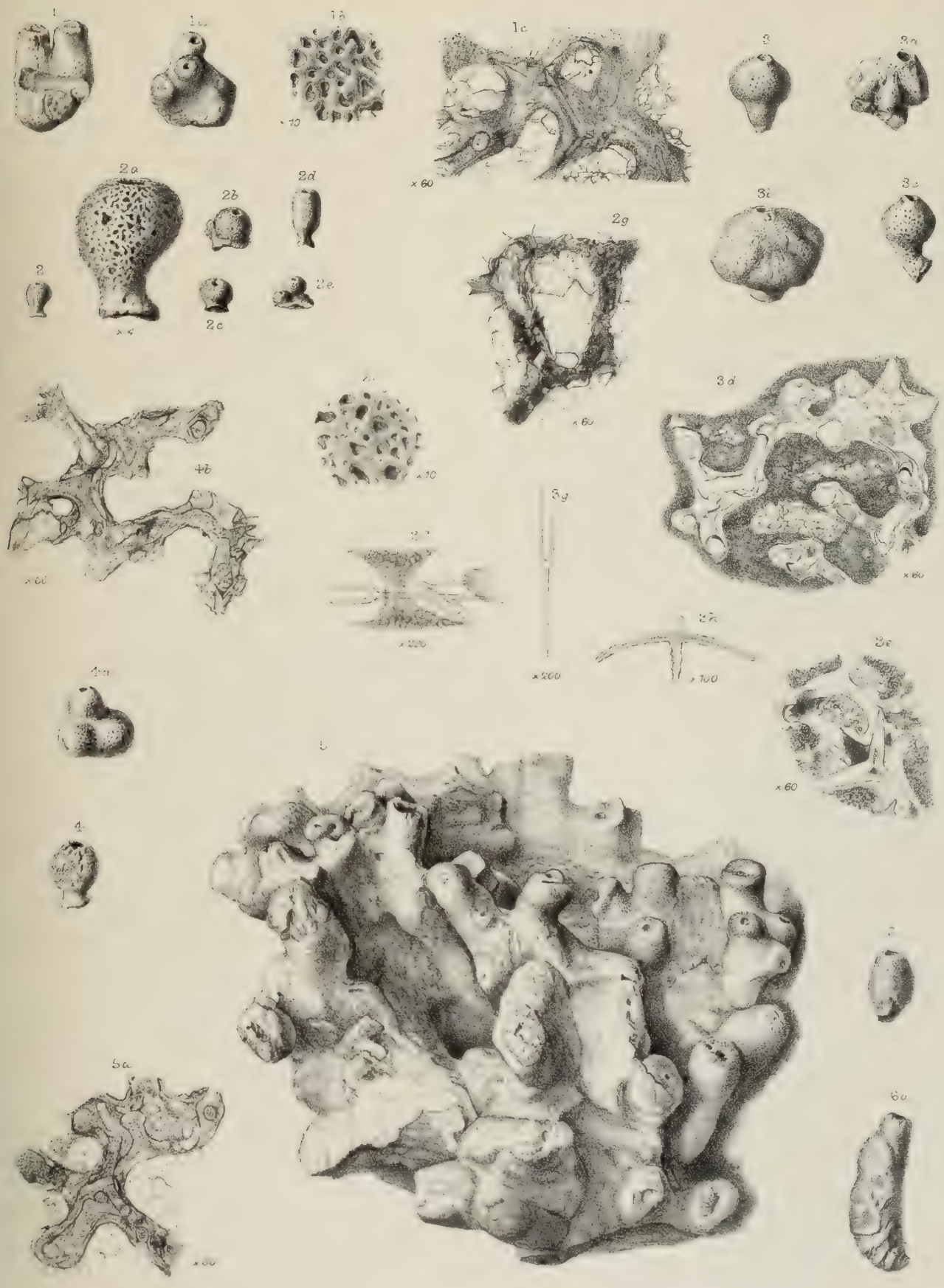
Figs. 5, 5 *a*.—Eusiphonella prolifera, *Hinde*, sp. nov. (Page 219.)

Fig. 5.—An end view of the type-specimen, showing the mode of growth. Natural size. Great Oolite, near Bath. British Natural History Museum.

Fig. 5 *a*.—Portion of a transverse section of one of the spongites, showing the spicular structure of the fibres. Enlarged 60 diameters.

Figs. 6, 6 *a*.—Corynella Chadwicki, *Hinde*, sp. nov. (Page 223.)

Two small examples of this species. Natural size. From the Coralline Oolite, zone of *Ammonites plicatilis*, at Langton Wold, near Malton, Yorkshire. (Coll. Mr. S. Chadwick.)



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JURASSIC SPONGES

PLATE XVI.

Figs. 1—1 *d*.—Corynella Chadwicki, *Hinde*, sp. nov. (Page 223.)

Fig. 1.—A large specimen, natural size. From the Coralline Oolite, *Plicatilis*-zone, at Langton Wold, near Malton, Yorkshire. (Collection Mr. S. Chadwick.)

Fig. 1 *a*.—A vertical median section, showing the cloacal tube and portions of the canals which open into it. Natural size.

Fig. 1 *b*.—A transverse section of another specimen, showing the thickness of the sponge-wall.

Fig. 1 *c*.—A fragment of the outer surface, showing the disposition of the fibres and the irregular pores between them. Enlarged 10 diameters.

Fig. 1 *d*.—Portion of a transverse section, showing the spicular structure of the fibres. Enlarged 60 diameters.

Figs. 2, 2 *a*.—Corynella Langtonensis, *Hinde*, sp. nov. (Page 222.)

Fig. 2.—A specimen from the Coral Rag at Langton Wold. Natural size. (Collection Mr. S. Chadwick.)

Fig. 2 *a*.—A portion of a transverse section of another specimen, showing the spicular fibres. Enlarged 60 diameters.

Figs. 3—3 *c*.—Corynella punctata, *Hinde*, sp. nov. (Page 222.)

Fig. 3.—A single individual. Natural size. From the Oolitic Marl of the Inferior Oolite at Ravensgate Hill, near Cheltenham. Collected by Mr. R. F. Tomes.

Figs. 3 *a*, 3 *b*.—Two small colonies. Natural size. From the same horizon and locality.

Fig. 3 *c*.—A portion of the exterior surface, showing the disposition of the fibres and the irregular ostial apertures. Enlarged 15 diameters.

Figs. 4—4 *f*.—Corynella cribrata, *Hinde*, sp. nov. (Page 224.)

Fig. 4.—A single individual, showing the furrowed character of the wall. Natural size.

Figs. 4 *a*, 4 *b*.—Two small colonies. Natural size. In 4 *a* the spongites scarcely at all project, whilst in 4 *b* they are more extended.

Figs. 4 *c*—4 *e*.—Three colonies showing variations in growth and size of the spongites. Natural size. All the specimens are from the Great Oolite at Hampton Cliffs, near Bath. Woodwardian Museum, Cambridge (Walton Collection).

Fig. 4 *f*.—A portion of a transverse section, showing the spicules forming the fibres. Enlarged 60 diameters.

Figs. 5—5 *e*.—Holcospongia polita, *Hinde*, sp. nov. (Page 228.)

Fig. 5.—A single individual. Natural size.

Figs. 5 *a*—5 *c*.—Three small colonies. Natural size. All from the Lower Coral Rag, *Perarmatus*-zone, at Suffield, Yorkshire. (Collection Mr. S. Chadwick.)

Fig. 5 *d*.—A portion of a transverse section, showing the disposition and the thickness of the fibres. Enlarged 10 diameters.

Fig. 5 *e*.—A portion of the same, showing the spicular character of the fibres. Enlarged 60 diameters.

Figs. 6—6 *c*.—Holcospongia floriceps, *Phillips*, sp. (Page 226.)

Fig. 6.—The type-specimen. Natural size. From the Lower Coral Rag at Hackness, Yorkshire. York Museum.

Fig. 6 *a*.—Another specimen, in which the surface furrows have been obliterated and only the fibrous mesh is shown on the exterior. From the Lower Coral Rag at Suffield, Yorkshire. (Collection Mr. S. Chadwick.)

Fig. 6 *b*.—A single spongite, broken off from a compound mass, showing the lower portion enclosed by a dermal layer. Natural size.

Fig. 6 *c*.—A portion of a transverse section taken from the type-specimen, showing the spicular structure of the fibres. Enlarged 60 diameters.

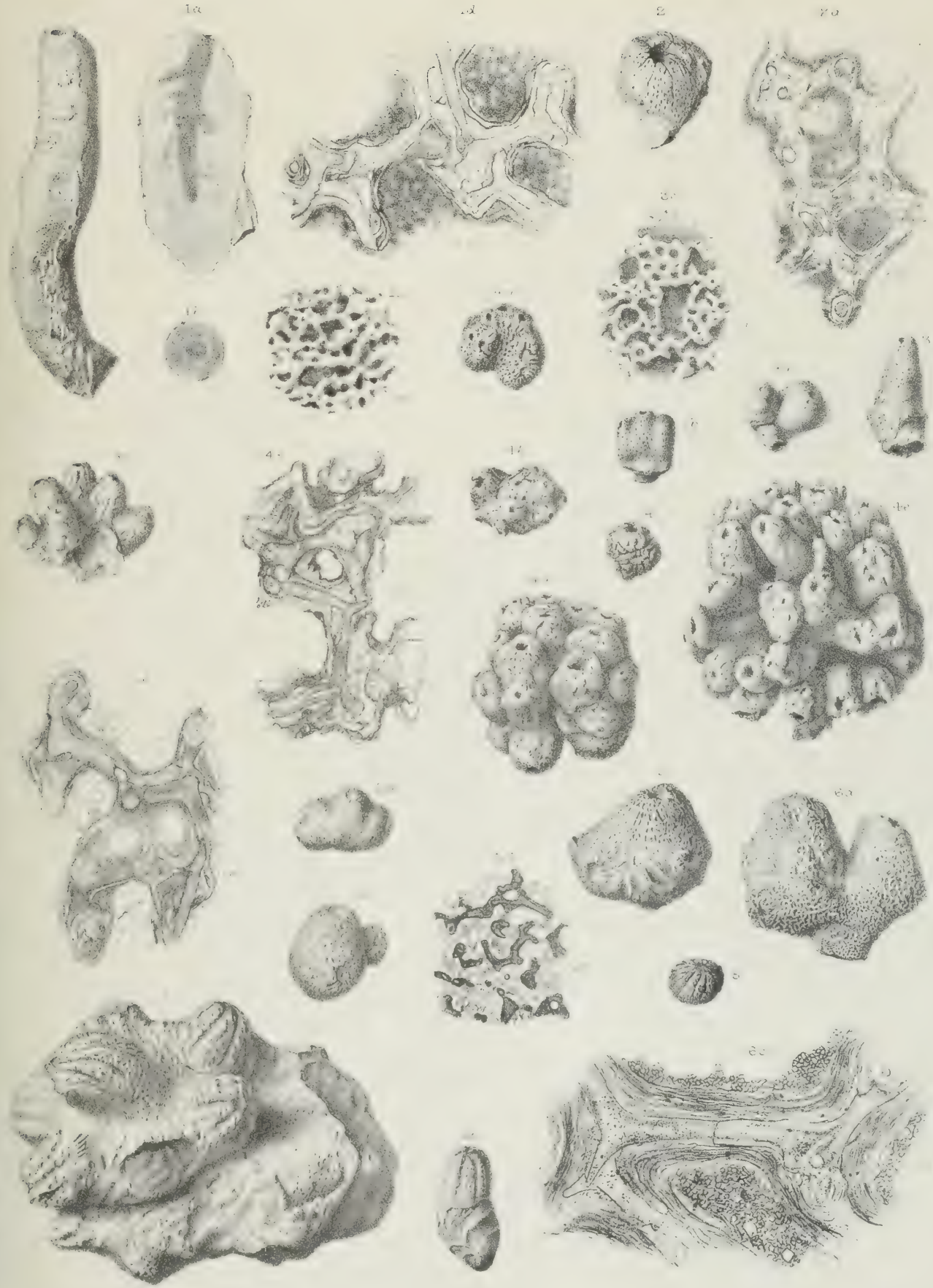

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PLATE XVII.

Figs. 1—1 *c*.—Holcospongia glomerata, *Quenstedt*, sp. (Page 228.)

Fig. 1.—Three simple individuals, attached to the surface of a specimen of *Corynella Chadwicki*. Natural size.

Fig. 1 *a*.—An ovate specimen, natural size. This and the preceding are from the Coralline Oolite, *Plicatilis*-zone, at Langton Wold, Malton, Yorkshire. (Collection Mr. S. Chadwick.)

Fig. 1 *b*.—Portion of a transverse section, enlarged 10 diameters, showing the disposition of the fibres.

Fig. 1 *c*.—Part of the same section, enlarged 60 diameters, showing the spicular structure of the fibres.

Fig. 2.—Holcospongia floriceps, *Phillips*, sp. (Page 226.)

Portion of a transverse section, enlarged 10 diameters, showing the disposition of the fibres.

Figs. 3—3 *h*.—Holcospongia sulcata, *Hinde*, sp. nov. (Page 229.)

Figs. 3, 3 *a*.—A specimen, enlarged 3 diameters, showing the upper (3 *a*) and under (3) surfaces.

Figs. 3 *b*—3 *e*.—Two specimens, natural size, showing the upper (3 *c*, 3 *e*) and the under (3 *b*, 3 *d*) surfaces.

Fig. 3 *f*.—Another specimen, showing the upper surface. Natural size.

Fig. 3 *g*.—Another specimen viewed laterally, showing the thickness and the curvature of the wall. Natural size. All the specimens are from the Inferior Oolite, *Parkinsoni*-zone, at Shipton Gorge, near Bridport. (Collection Mr. E. A. Walford.)

Fig. 3 *h*.—A portion of a transverse section of the fibres, enlarged 60 diameters.

Figs. 4—4 *d*.—Holcospongia contorta, *Hinde*, sp. nov. (Page 230.)

Fig. 4.—A club-shaped specimen, enlarged 2 diameters, showing the grooved surface.

Fig. 4 *a*.—A small specimen, attached to a fragment of shell. Enlarged 4 diameters.

Figs. 4 *b*, 4 *c*.—Small pisiform specimens. Natural size. All the specimens are from the Inferior Oolite, *Parkinsoni*-zone, at Shipton Gorge. (Collection Mr. E. A. Walford.)

Fig. 4 *d*.—A portion of the surface of the dermal layer, showing large three-rayed spicules and traces of smaller ones beneath. Enlarged 60 diameters.

Figs. 5—5 *c*.—Holcospongia liasica, *Quenstedt*, sp. (Page 231.)

Figs. 5, 5 *a*.—The upper and under surface of the same specimen. Natural size.

Fig. 5 *b*.—A compound specimen, in which one individual is partially overgrowing another. Natural size. The specimens are from the Inferior Oolite, *Parkinsoni*-zone, at Shipton Gorge. (Collection Mr. E. A. Walford.)

Fig. 5 *c*.—Portion of a transverse section, showing the spicular fibres. Enlarged 60 diameters.

Figs. 6—6 *e*.—Holcospongia bella, *Hinde*, sp. nov. (Page 232.)

Fig. 6.—A specimen showing the upper surface. Enlarged 3 diameters.

Figs. 6 *a*—6 *c*.—The upper, lower, and side views of the same specimen. Natural size.

Fig. 6 *d*.—A specimen showing the upper surface. All the specimens are from the Inferior Oolite, *Parkinsoni*-zone, at Shipton Gorge, Dorset. (Collection Mr. E. A. Walford.)

Fig. 6 *e*.—Portion of a transverse section, showing the spicular fibres surrounded by crystalline calcite. Enlarged 60 diameters.

Figs. 7—7 *d*.—Holcospongia mitrata, *Hinde*, sp. nov. (Page 232.)

Figs. 7—7 *b*.—Three different specimens. Enlarged 4 diameters. From the Inferior Oolite, *Parkinsoni*-zone, at Shipton Gorge. (Collection Mr. E. A. Walford.)

Fig. 7 *c*.—A portion of the outer surface, showing the ostia. Enlarged 10 diameters.

Fig. 7 *d*.—A portion of the dermal layer, showing some of the component three-rayed spicules. Enlarged 60 diameters.

Fig. 8.—Myrmecium biretiforme, *Sollas*. (Page 233.)

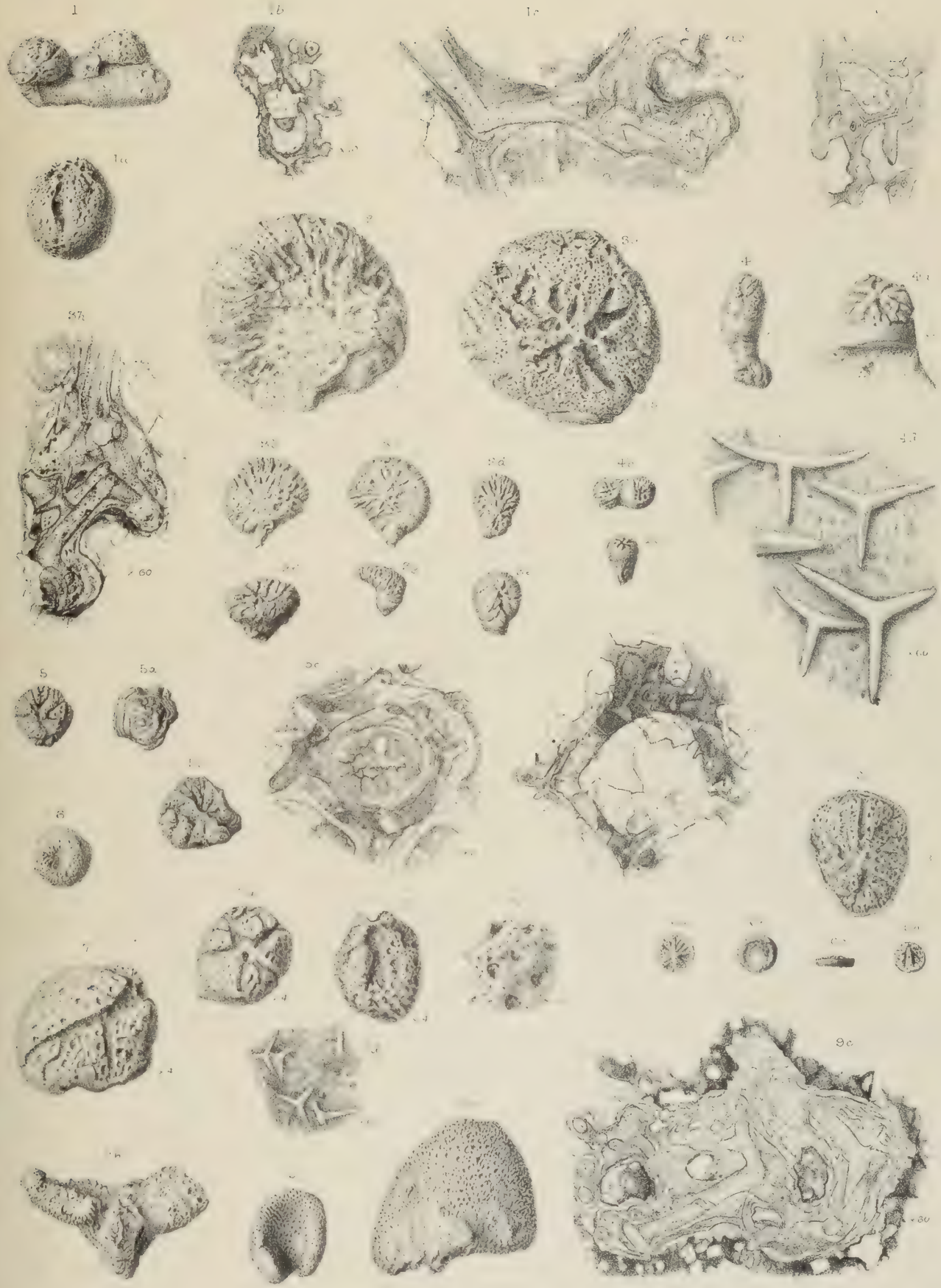
The type-specimen referred to this species, showing the summit. Natural size. From the Inferior Oolite, *Parkinsoni*-zone, at Burton Bradstock. (Collection Rev. G. F. Whidborne.)

Figs. 9—9 *c*.—Elasmostoma palmatum, *Hinde*, sp. nov. (Page 243.)

Figs. 9, 9 *a*.—Two small fan-shaped specimens. Natural size. In Fig. 9 the dermal layer has been removed; in 9 *a* the under or non-oscular surface is shown.

Fig. 9 *b*.—A lobate specimen, the surface partially covered with the dermal layer. Natural size. All the specimens are from the Great Oolite, Hampton Cliffs, near Bath. Woodwardian Museum, Cambridge (Walton Collection).

Fig. 9 *c*.—A portion of a transverse section, showing the spicular structure of the fibres. Enlarged 60 diameters.



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JURASSIC SPONGES

PLATE XVIII.

Figs. 1, 1 *a*.—ELASMOSTOMA PALMATUM, *Hinde*, sp. nov. (Page 243.)

Fig. 1.—A specimen showing the upper or oscular surface. Natural size. The dermal layer is only partly preserved. Several small oysters are attached to it. From the Great Oolite at Hampton Cliffs, near Bath. Woodwardian Museum, Cambridge (Walton Collection).

Fig. 1 *a*.—A portion of the dermal layer of another specimen, showing three-rayed spicules weathered out on the surface. Enlarged 60 diameters.

Figs. 2—2 *c*.—LYMNORELLA MAMILLOSA, *Lamx.* (Page 235.)

Fig. 2.—A large specimen showing the upper surface, with its oscules and ostia. Natural size. From the Inferior Oolite, Pea-grit series, at Crickley Hill, near Cheltenham. (Collection Mr. R. F. Tomes.)

Fig. 2 *a*.—Portion of a transverse section, showing the tubular excurrent canals or cloacæ; the horizontal canals and the small incurrent canals connected with the ostia. Enlarged 2 diameters.

Fig. 2 *b*.—A vertical section, natural size, showing concentric zones of growth and excurrent canals.

Fig. 2 *c*.—Portion of a microscopic section, showing the axial spicules and the crystalline condition of the fibres. Enlarged 60 diameters.

Figs. 3—3 *d*.—LYMNORELLA INCLUSA, *Hinde*. (Page 236.)

Fig. 3.—A specimen with a flattened base, showing the upper surface and successive layers of growth. Small sunken oscules are shown, and one or two small oysters are attached to the surface. Natural size. Inferior Oolite, Pea-grit, Crickley Hill, near Cheltenham. (Collection Mr. R. F. Tomes.)

Fig. 3 *a*.—The type of the species. Natural size. From the Pea-grit, near Cheltenham. British Natural History Museum.

Fig. 3 *b*.—Part of a vertical section, showing the disposition of the fibres. Enlarged 10 diameters.

Fig. 3 *c*.—Part of a thickened fibre, showing the axial three-rayed spicules and the radiately crystalline character of the fibre. Enlarged 60 diameters.

Fig. 3 *d*.—A tuning-fork spicule from the fibre of the same section as 3 *c*. Enlarged 200 diameters.

Figs. 4—4 *b*.—LYMNORELLA PYGMÆA, *Sollas*. (Page 238.)

Fig. 4.—A compound specimen, showing the spongites and the dermal layer. Natural size. Inferior Oolite, Shipton Gorge. (Collection Mr. E. A. Walford.)

Fig. 4 *a*.—A specimen showing the conical spongites of the upper surface. Natural size. Inferior Oolite, Pea-grit series, near Cheltenham.

Fig. 4 *b*.—A simple individual. Natural size. Inferior Oolite, at Shipton Gorge. (Collection Mr. E. A. Walford.)

Figs. 5—5 *d*.—LYMNORELLA MICULA, *Hinde*. (Page 239.)

Figs. 5, 5 *a*.—Two nodose somewhat lobate specimens, showing traces of zonal layers of growth. Natural size. From the Great Oolite at Hampton Cliffs, near Bath. Woodwardian Museum, Cambridge (Walton Collection).

Fig. 5 *b*.—A portion of a vertical section, showing the spicular fibres. Enlarged 60 diameters.

Fig. 5 *c*.—A very perfect tuning-fork spicule, from the outer portion of the fibres. Enlarged 200 diameters.

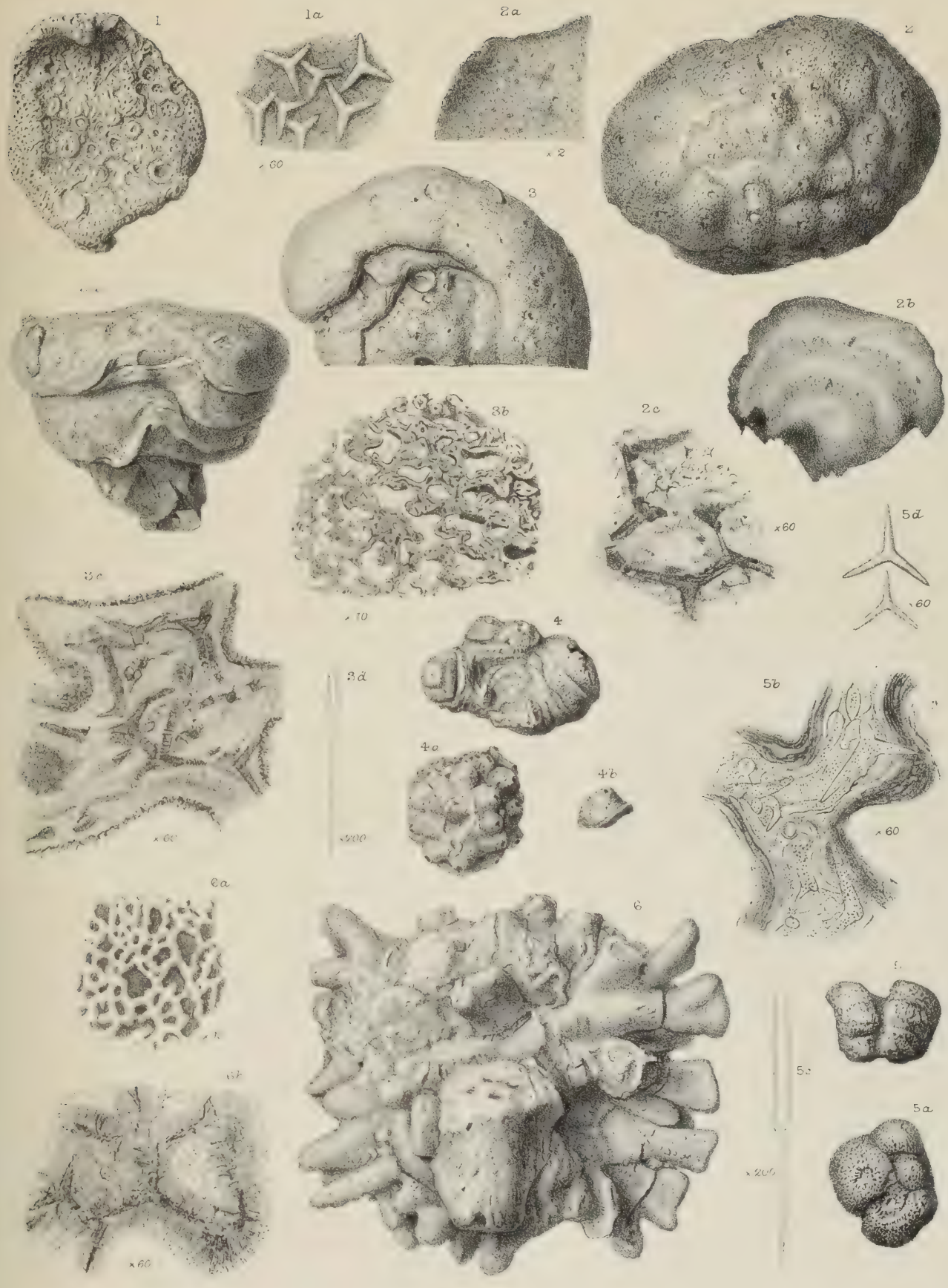
Fig. 5 *d*.—Two three-rayed spicules from the surface of the dermal layer. Enlarged 60 diameters.

Figs. 6—6 *b*.—LYMNORELLA RAMOSA, *Hinde*, sp. nov. (Page 238.)

Fig. 6.—A specimen seen from the under surface, showing the branches growing from a basal stock. Natural size. From the Inferior Oolite at Andoversford, near Cheltenham. Collected by Mr. R. F. Tomes.

Fig. 6 *a*.—A portion of the surface, enlarged 10 diameters, showing a group of the larger apertures.

Fig. 6 *b*.—A portion of a transverse section, showing the spicular fibres. Enlarged 60 diameters.



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JURASSIC SPONGES.

PLATE XIX.

Figs. 1—1 *c*.—Eudea Walfordi, *Hinde*, sp. nov. (Page 241.)

Figs. 1, 1 *a*, 1 *b*.—Three specimens, each enlarged 3 diameters. The outline figures represent the natural size. From the Inferior Oolite, *Parkinsoni*-zone, at Shipton Gorge, Dorset. (Collection Mr. E. A. Walford.)

Fig. 1 *c*.—A transverse section through a specimen, showing the cloacal tube and the disposition of the fibres. Enlarged 10 diameters.

Figs. 2—2 *b*.—Eudea pisum, *Quenstedt*, sp. (Page 242.)

Three specimens, each enlarged 3 diameters. From the Inferior Oolite at Shipton Gorge. (Collection Mr. E. A. Walford.)

Figs. 3, 3 *a*.—Diaplectia auricula, *Hinde*. (Page 245.)

Fig. 3.—The type-specimen, showing the outer surface of the wall. Natural size. From the Inferior Oolite, Pea-grit series, near Cheltenham. British Nat. Hist. Museum.

Fig. 3 *a*.—Portion of a transverse section, showing the spicular fibres. Enlarged 60 diameters.

Figs. 4, 4 *a*.—Diaplectia infundibulum, *Hinde*, sp. nov. (Page 245.)

Fig. 4.—The type-specimen. Natural size. From the Great Oolite at Bradford, Wiltshire. Woodwardian Museum, Cambridge.

Fig. 4 *a*.—Portion of the inner surface, showing the character of the interspaces between the fibres. Enlarged 10 diameters.

Figs. 5—5 *c*.—Blastinia costata, *Goldfuss*, sp. (Page 246.)

Fig. 5.—A specimen showing the ridged upper surface. Enlarged 4 diameters. From Jurassic strata in the Richmond (Surrey) well-boring, at 1205 feet beneath the surface.

Figs. 5 *a*, 5 *b*.—Two specimens, showing the ridges of the upper surface. The depressions are partially filled with matrix. Enlarged 2 diameters. From the Oolite-Marl of the Inferior Oolite at Ravensgate Hill, near Cheltenham. Collected by Mr. R. F. Tomes.

Fig. 5 *c*.—Portion of a transverse section of a specimen from Ravensgate Hill, showing the spicular fibres. Enlarged 60 diameters.

Figs. 6—6 *d*.—Blastinia aspera, *Hinde*, sp. nov. (Page 247.)

Fig. 6.—A conical specimen with flattened base. Natural size.

Fig. 6 *a*.—A compound specimen, showing several ridged individuals growing on a common base. Natural size.

Fig. 6 *b*.—A simple specimen with laterally corrugated ridges or crests. Natural size. All the specimens are from the Coral Rag at Suffield, Yorkshire. (Collection Mr. S. Chadwick.)

Fig. 6 *c*.—A portion of a transverse section, showing the great thickness of the skeletal fibres in the ridges. Enlarged 10 diameters.

Fig. 6 *d*.—Another portion, showing the spicular structure of the fibres. Enlarged 60 diameters.

Figs. 7—7 *b*.—Oculospongia minuta, *Hinde*. (Page 240.)

Fig. 7.—A specimen showing a lateral view, natural size, and the upper surface enlarged 3 diameters. From the Inferior Oolite, *Parkinsoni*-zone, at Shipton Gorge, Dorset. (Collection Mr. E. A. Walford.)

Fig. 7 *a*.—Another specimen, showing the upper surface, on which a *Serpula* is attached. Enlarged 4 diameters. From the Jurassic Strata in the Richmond (Surrey) well-boring, at a depth of 1205 feet below the surface.

Fig. 7 *b*.—Portion of a transverse section of a specimen from Shipton Gorge, showing the spicular structure of the fibres. Enlarged 60 diameters.

Figs. 8—8 *x*.—Leucandra Walfordi, *Hinde*. (Page 248.)

Figs. 8—8 *c*.—Four specimens showing their mode of growth. Enlarged 10 diameters. The outline figure near the base of each represents the natural size. The specimens are all from the Marlstone of the Middle Lias at King's Sutton, Northamptonshire. Collected by Mr. E. A. Walford.

Fig. 8 *d*.—The summit of a specimen showing the aperture of the cloacal tube. Enlarged 10 diameters.

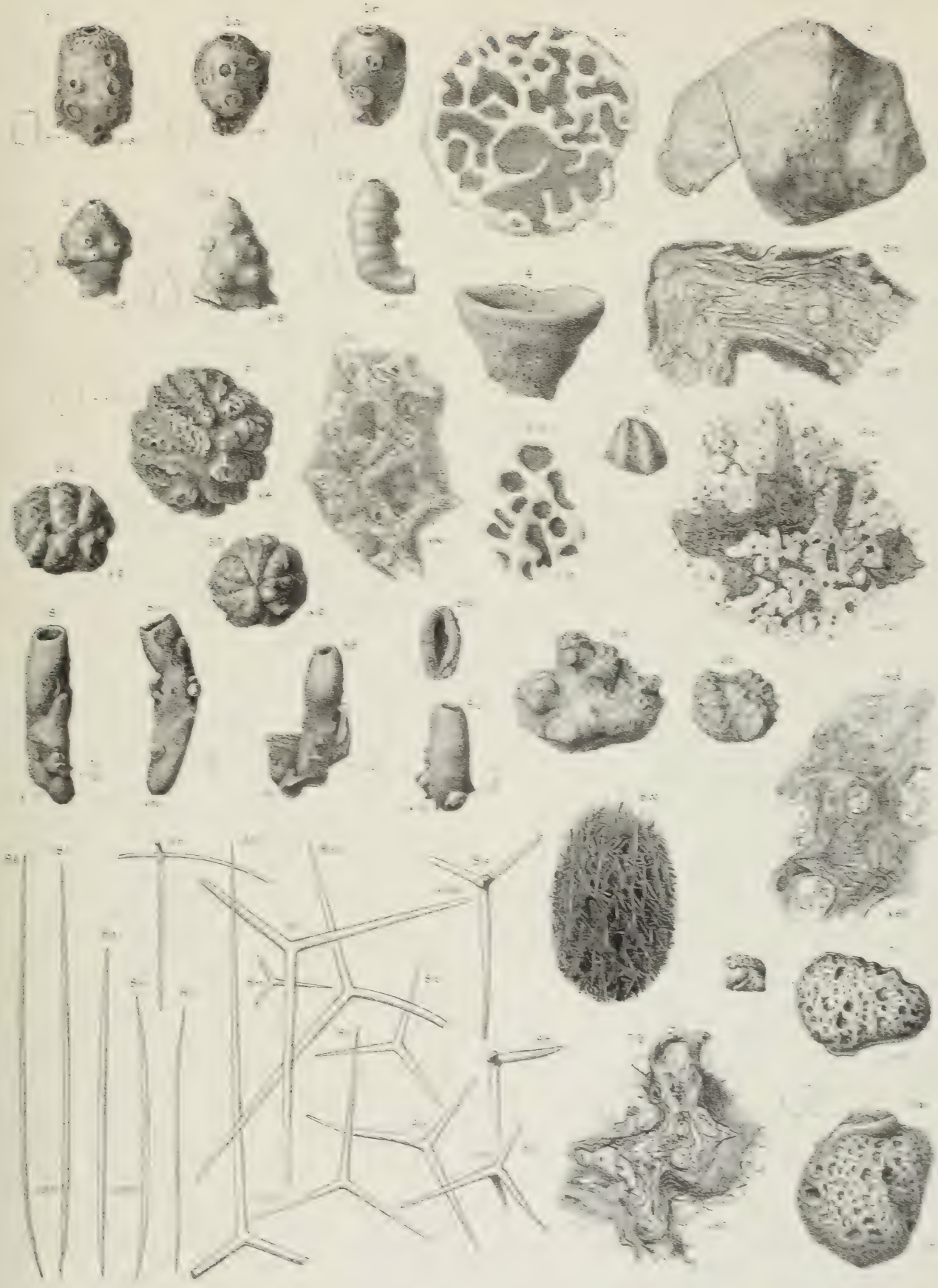
Figs. 8 *e*—8 *i*.—Five simple acerate spicules. Enlarged 200 diameters.

Figs. 8 *k*—8 *q*.—Three-rayed spicules of various dimensions. All enlarged 200 diameters. In many the rays are only in part preserved.

Fig. 8 *r*.—A sagittate four-rayed spicule, similarly enlarged.

Figs. 8 *s*—8 *u*.—Four-rayed spicules, mostly imperfect. Similarly enlarged.

Fig. 8 *x*.—A portion of the outer surface of the wall, showing the disposition of the simple rod-like spicules and traces of circular canal apertures. Enlarged 60 diameters.



A. T. Hollick del. et lith.

THE

PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCXLVII.

VOLUME FOR 1893.

LONDON:

MDCCCXCIII.

A MONOGRAPH

ON THE

BRITISH FOSSIL

ECHINODERMATA

FROM

THE CRETACEOUS FORMATIONS.

VOLUME SECOND.

THE ASTEROIDEA.

BY

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SECRETARY OF THE LINNEAN SOCIETY.

PART SECOND.

Pages 29—66; Plates IX—XVI.

LONDON:

PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.

1893.

PRINTED BY ADLARD AND SON,
BARTHOLOMEW CLOSE, E.C., AND 20, HANOVER SQUARE, W.

adambulacral plates is also noteworthy. This seems to indicate the former presence of a distinct furrow series of spinelets or granules much smaller than usual, followed by granules or spinelets borne on the outer part of the plate, more irregularly placed than in the other forms described, and articulated on punctured eminences.

The example which is represented in fig. 4 *a* also has a narrower marginal border of infero-marginal plates than the type. The punctation of the infero-marginal plates is smaller than in the type, and does not present the striking scrobiculate character noticed in that example. The markings are rather to be described as lipped pits, and some granules are still *in situ*. The actinal intermediate plates do not have the retiform and crenulate ornamentation shown in the plates belonging to the specimen figured in 3 *a*, but the margins of the punctations are strongly lipped. The supero-marginal plates are less regular and much less high than in the type specimen, but they are not perfectly preserved.

Dimensions.—In the type specimen (figured on Pl. IV, fig. 2 *a*) the major radius is about 41 mm., and the minor radius 26 mm. Breadth of a ray between the third and fourth infero-marginal plates, counting from the median interradial line, about 12 mm. or rather more. Thickness of the margin about 8·5 mm.

The specimen given in fig. 3 *a* has a major radius of about 39 mm. and a minor radius of 24 mm.

The specimen given in fig. 4 *a* has a major radius of about 41 mm. and a minor radius of 25·5 mm. Breadth of the ray between the third and fourth infero-marginal plates about 11 to 12 mm., or rather more.

Locality and Stratigraphical Position.—The type specimen, which is now preserved in the British Museum, is labelled from the "Lower Chalk" of "Sussex," but is stated by Forbes to have been obtained from the Upper Chalk. Other examples of the species have been collected from the Upper Chalk of Bromley, Sittingbourne, Purfleet, Gravesend, Sussex, and Wiltshire. Fine series are preserved in the British Museum and in the Museum of Practical Geology, Jermyn Street.

History.—The specimen which I have taken as the type of this species was originally referred by Forbes to the *Asterias lunatus* of Woodward, and was figured by him as that species in Dixon's 'Geology and Fossils of the Tertiary and Cretaceous Formations of Sussex' (pl. xxiii, fig. 9). The same example is carefully represented on Pl. IV, fig. 2 *a*, of this memoir.

Remarks.—It will be at once seen on referring to the figures that Woodward's *Pentagonaster lunatus*, which is drawn on Pl. IV, fig. 1 *a*, of this Monograph, is a distinct species. The rays are more produced, and are narrower at the base. The infero-marginal plates are twice as numerous, the marginal border is less broad, and the plates are much shorter in proportion to their breadth. Their punctation is also different. The actinal intermediate plates are smaller in relation to the size of the actinal interradial areas, and their punctation is different from that which characterises *Pentagonaster megaloplax*. The armature of the adambulacral plates also appears to be more regular in its arrangement.

Under these circumstances I have no hesitation in considering the form under description a distinct species. I much regret having to impose a new name, as this form has for a long time been known under the specific name of *lunatus;* the course, however, seems unavoidable, as the actual type of the real *Pentagonaster lunatus* described by Woodward is in existence, and there can, in my opinion, be no question as to its being a different species.

Since the preceding sheet was printed off I have found several specimens in the British Museum which show the abactinal aspect of the disk. I have little hesitation in referring these examples to *Pentagonaster megaloplax*, and a drawing of one of them is given on Pl. XIII, fig. 1 *a*. The infero-marginal plates all show more or less distinctly the characteristic " scrobiculate " or areolated pits already described. A similar ornamentation also extends upon the supero-marginal plates, but is confined to the lateral wall which falls in the margin of the disk. The curvature which unites the abactinal and lateral areas of the plate is more or less abrupt, and the lateral wall of the disk is consequently vertical and not rounded, as a rule. The abactinal area of the supero-marginal plates is covered with small, uniform, granular eminences (see Pl. XIII, fig. 1 *b*). Two or three supero-marginal plates at the extremity of the ray meet the corresponding plates of the opposite side of the ray in the median radial line, and a rapid diminution in breadth occurs as they approach the extremity.

Genus—METOPASTER, *Sladen.*

[Μέτωπον = a cheek-piece.]

Body depressed and pentagonal or stellato-pentagonal in contour, the rays being produced to a very slight degree. Marginal plates covered with well-spaced uniform punctations, upon which granules were originally borne, and surrounded by a narrow depressed border with very minute and crowded puncta-

tions for the articulation of setæ. Supero-marginal plates ordinarily few in number, and form a broad border to the disk. Ultimate paired supero-marginal plates the largest of the series. Abactinal area covered with polygonal, and usually hexagonal, plates (some of which may have stellate bases), and upon the tabulæ are borne small, more or less co-ordinated granules. Infero-marginal plates more numerous than the supero-marginal series, and decreasing in size as they approach the extremity of the ray. Their ornamentation similar to that of the superior series. Actinal intermediate plates small, polygonal, covered with uniform granules. Armature of the adambulacral plates arranged in longitudinal lines. Small entrenched pedicellariæ may be present occasionally on the plates.

Metopaster differs from *Pentagonaster* by the large ultimate paired supero-marginal plates, by the comparatively small number of the supero-marginal plates, which are also fewer in number than the infero-marginal series, and by the character of the ornamentation of the marginal plates of both series.

The forms ranked under this genus were all classed by the late Professor Edward Forbes under *Goniodiscus*, which he considered to be a sub-genus of *Goniaster*. There is, however, no justification whatever in my opinion for regarding any of the Cretaceous starfishes hitherto described as belonging to either the genus *Goniaster* or *Goniodiscus*. The species which may be considered as the types of each of these genera are existing forms, and no Cretaceous forms agreeing in structural detail have, so far as I am aware, been discovered. It is also erroneous to rank *Goniodiscus* as a sub-genus of *Goniaster*. The two genera belong to different families; and I am in perfect accord with Professor Edmond Perrier as to the limitation of the two genera. His view appears to me to be perfectly logical, and to be the result of careful and impartial judgment. I also consider that the fossil forms under consideration are quite distinct from the recent genus *Astrogonium*, as limited by me elsewhere.[1]

1. Metopaster Parkinsoni, *Forbes*, sp. Pl. IX, figs. 2 *a*—2 *c*; Pl. X, figs. 1 *a*—5 *c*; Pl. XI, figs. 1 *a*—2 *c*; Pl. XII, figs. 1 *a*—1 *d*; Pl. XVI, figs. 2 *a*, 2 *b*.

Pentagonaster regularis, *Parkinson*, 1811. Organic Remains, vol. iii, p. 3, pl. i, fig. 3 (*non* Linck).

Tosia regularis, *Morris*, 1843. Catalogue of British Fossils, p. 60.

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[1] 'Zool. Chall. Exped.,' part li, "Report on the Asteroidea," 1889, p. 285.

GONIASTER (GONIODISCUS) PARKINSONI, *Forbes*, 1848. Memoirs of the Geological Survey of Great Britain, vol. ii, p. 472.

— — RECTILINEUS, *McCoy*, 1848. Ann. and Mag. Nat. Hist., ser. 2, vol. ii, p. 408.

— — PARKINSONI, *Forbes*, 1850. In Dixon's Geology and Fossils of the Tertiary and Cretaceous Formations of Sussex, London, 4to, p. 332, pl. xxi, figs. 10, 11; pl. xxii, figs. 5—7.

— — — *Morris*, 1854. Catalogue of British Fossils, 2nd ed., p. 81.

— — RECTILINEUS, *McCoy*, 1854. Contrib. Brit. Pal., p. 55.

— — — *Morris*, 1854. Catalogue of British Fossils, 2nd ed., p. 81.

ASTROGONIUM PARKINSONI, *Dujardin and Hupé*, 1862. Hist. Nat. Zooph. Échin. (Suites à Buffon), p. 399.

— RECTILINEUM, *Dujardin and Hupé*, 1862. Ibid., p. 400.

GONIASTER (GONIODISCUS) PARKINSONI, *Forbes*, 1878. In Dixon's Geology of Sussex (new edition, Jones), p. 365, pl. xxiv, figs. 10, 11; pl. xxv, figs. 5—7.

PENTAGONASTER RECTILINEUS, *Woods*, 1891. Catalogue of the Type Fossils in the Woodwardian Museum, Cambridge, p. 36.

Body of medium size. General form depressed. Abactinal surface flat, with a tendency, however, for the extremity of the rays to be slightly upturned; as found in the fossil state the area occupied by the abactinal plates is usually at a lower level than the marginal plates, which leads to the assumption that the abactinal floor had collapsed or fallen to a certain extent on the death of the animal. Actinal surface slightly convex. Marginal contour pentagonal, with slightly lunate sides, the curvature being often flattened at right angles to the median interradial line. The major radius measures about one-third more than the minor radius, and frequently less than one-third; the rays are consequently very feebly produced. Margin thick and well rounded.

The supero-marginal plates are four in number, counting from the median interradial line to the extremity, or eight from the tip of one ray to the tip of the adjacent ray, exclusive of the odd terminal or "ocular" plate in each case. They form a broad border to the abactinal area of the disk of uniform breadth throughout, which measures about 9 mm. at the median interradial line in an example whose minor radius measures 30 mm. Excepting the ultimate paired plates all the supero-marginal plates are of equal size, the breadth being about

twice the length, the actual measurements in the specimen under notice being, length 4·75 mm. and breadth 9·5 mm. respectively, *i. e.* as 1 : 2. The abactinal surface of these plates is distinctly convex, with a slight depression along their margins of juncture, formed by a well-defined bevel along the sides and adcentral end. The general surface of the whole series is well rounded, the curvature being regular and uninterrupted between the adcentral margin of the plate and the margin in the lateral wall adjacent to the infero-marginal plates. The height of the plates as seen in the margin is a little greater than their length, and there is no diminution in height as the plates approach the extremity of the ray—in fact, the ultimate paired plate is not unfrequently higher than the other plates in consequence of a tendency to become gibbous on its abactinal surface. The whole superficies of the plates is covered with small, widely spaced, equidistant, uniform punctations, and there is a depressed border along the margin of the plate, varying slightly in breadth in different examples, covered with much smaller and closely crowded punctations, upon which much smaller granules than those upon the median area of the plate were originally borne. Traces of these granules may occasionally be found *in situ*.

The ultimate paired plate is larger than any of the other supero-marginal plates, and is of a different shape. It is subtriangular in form as seen from above, and one margin touches the corresponding plate of the adjacent side of the disk throughout, the junction coinciding with the median radial line of the disk. The length of this margin of the plate is subequal to or only slightly greater than the breadth of the preceding marginal plates. In small specimens the subequal measures are the rule, whilst in larger examples the plate becomes more elongate and produced in the direction of the prolongation of the ray. When viewed in the margin of the test the form of the ultimate plate strikingly resembles that of the carapace of some Coleoptera. The length of the plate in this aspect, measured from its outer extremity to the margin adjacent to the penultimate plate, is in small and medium sized specimens about once and a half the length of the other marginal plates, but in large examples it may be as much as, or even exceed, twice their length. The surface of the ultimate plate bears a similar ornamentation to that on the other supero-marginal plates.

The odd terminal plate is very small, appearing externally when denuded of granules like a truncate cylinder, having a fanciful resemblance to a cannon projecting from a porthole. This plate seems to be very rarely preserved *in situ* in the fossil state. In a remarkably good specimen belonging to the British Museum Collection (marked "E 2034") (see Pl. XVI, figs. 2 *a*, 2 *b*) each of the terminal plates preserved bears at its outer truncate extremity a single horizontally placed entrenched pedicellaria. Whether this regularly placed pedicellaria is always present on the odd terminal plate in this species I am unable to say.

The abactinal area of the disk within the boundary of the marginal plates is covered with small sub-regular plates or paxillar tabulæ, an hexagonal form predominating especially in the radial regions; and a small but distinct diminution in size takes place as the plates approach the margin of the disk. All the plates have their surface marked with minute, shallow, and closely placed punctations—the impressions of the attachment of the granules previously present. The primary basal plates are larger than any of the other abactinal plates, and they are well shown in several of the drawings illustrative of this species (see Pl. X, figs. 1, 2 *a*). Occasional plates bear small entrenched pedicellariæ, the normal form consisting of a small, central, lipped foramen with a lateral trench on each side. It frequently happens, however, that the organ exhibits a more complex development, and assumes a stellate form in consequence of the presence of additional trenches—five or six being not an unusual number—which radiate from the central foramen; the whole being placed on a small hemispherical elevation, and producing an appearance shown on Pl. X, fig. 2 *d*.

The madreporiform body is large and subtriangular in outline; and its surface is sculptured by very fine striations which radiate from the centre to the margin, with more or less wavy lines here and there (see Pl. X, fig. 2 *c*). The margin of the plate is surrounded by three large plates, one on the adcentral side of the madreporite towards which it presents a straight suture; the other two plates are on the remaining sides of the triangular body, and they have a concave curve directed towards the madreporite to correspond with the convexity of its sides. The position of the madreporite is nearer the centre of the disk than the margin.

The infero-marginal plates are seven in number, counting from the median interradial line to the extremity—that is to say, there are fourteen for the whole side of the disk, as against eight in the supero-marginal series. The length of the three innermost plates on each side of the median interradial line is equal to that of the superior series, but there are four infero-marginal plates corresponding to the large ultimate supero-marginal. As seen in the lateral wall of the disk the height of the infero-marginal plates is less than that of the supero-marginal series. The breadth of these plates adjacent to the median interradial line on the actinal surface is 7·5 mm. in an example whose major radius measures 36·5 mm. and the minor radius 27·5 mm. The breadth of the marginal border rapidly diminishes towards the extremity of the ray. The surface of the plates is ornamented in a precisely similar manner to that of the supero-marginal plates. A narrow border of smaller granulation is also present round the whole margin of the plate, similar in all respects to that already described in the case of the superior series of plates.

The adambulacral plates are small, about or nearly twice as broad as long, and

their surface is traversed by four or five ridges running parallel to the ambulacral furrow, with punctures upon which the spinelets composing the armature were articulated. There were four or five spinelets in each lineal series. The spinelets are short, their length being about equal to the length of the plate, stumpy, compressed, slightly tapering and rounded at the extremity; and all appear to have been uniform.

The actinal intermediate plates are rather large for the genus; those adjacent to the adambulacral plates are pentagonal in form, but elsewhere they are subhexagonal, or perhaps more correctly polygonal. The plates are very large on the inner portion of the area, but diminish greatly in size at the outer margin of the disk adjacent to the marginal plates. The surface of the intermediate plates is entirely covered with small, equidistant punctations, upon which a uniform close granulation was previously attached. Remains of this granulation are still occasionally to be seen *in situ* on plates here and there in the example under notice. Entrenched pedicellariæ similar to those above described on the plates of the abactinal surface occur on a number of the plates in the series adjacent to the adambulacral plates, but the organ does not appear to diverge, or only very rarely, from the normal form of a central foramen and two lateral trenches.

Dimensions.—In the specimen figured on Pl. X, fig. 2 *a*, the major radius is 38 mm., and the minor radius 30 mm. Other examples have the following approximate measurements: R = 35 mm., *r* = 27 mm.; R = 43 mm., *r* = 34 mm. The diameter of the disk (R + *r*) in well-grown tests ranges, therefore, from 60 mm. to 80 mm. The thickness of the margin is about 11·75 mm.

Locality and Stratigraphical Position.—All the examples figured in this Monograph were obtained from the Upper Chalk, near Bromley. The species is a characteristic Upper Chalk fossil in the south of England, and has been found in beds of that age at Brighton, Charlton, Gravesend, Kent, and other localities. It is stated by Forbes to occur in the Lower Chalk of Sussex, but I have not seen any examples from that horizon.

History.—A fossil starfish which has been generally considered to be this species was figured by Parkinson in his 'Organic Remains of a Former World,' vol. iii, pl. i, fig. 3, but it was referred by that author to the *Pentagonaster regularis* of Linck. The last named has, however, been supposed to be a recent species, but the type has unfortunately been lost, and the form has not subsequently been recognised definitely. Apart from this the fossil starfishes now under notice are certainly distinct from the form indicated by Linck's figure, and this view was taken by Forbes, who named the species after Parkinson in his memoir 'On the Asteriadæ found fossil in British Strata,' and figures of the

fossils so named by him were given in Dixon's 'Geology and Fossils of the Tertiary and Cretaceous Formations of Sussex,' London, 1850. One, if not more, of the specimens delineated in that work is now preserved in the British Museum.

Variations.—In some examples the breadth of the border formed by the supero-marginal plates on the abactinal surface is greater in relation to the disk-area than in others, and this variety was noted by Forbes ('Mem. Geol. Surv.,' vol. ii, p. 472). I have not been able to establish the relation of this modification with any other permanent morphological character, nor to associate it with any special locality or stratum, and I am therefore led to consider, for the present at least, that the variation in question is one affecting individual examples of the species independently of other structural modifications which would warrant recognition by name.

Two other variations are to be noted in this species which are superficially much more striking, and either of them would, if only isolated examples were known, lend a strong temptation to the separation of their possessor from the normal form of the species. One of the variations in question affects the large ultimate paired supero-marginal plates. On comparing the examples drawn on Pl. X, fig. 1 and fig. 2 *a*, with fig. 1 *a*, Pl. XII, and fig. 1 *a*, Pl. XI, it will be seen that the ultimate plates are relatively much larger than the adjacent supero-marginal plates and are more produced at the extremity; whilst in the specimen delineated in fig. 2 *a*, Pl. XI, this modification is carried to such an extent that at first sight it would appear scarcely possible to believe that this fossil belongs to the same species as, for example, fig. 2 *a*, Pl. X. I have, however, been unable to find any other constant variation from what has been considered the typical form of *Metopaster Parkinsoni* associated with this modification in the size and shape of the ultimate plates; and as the most complete gradation between the two extremes may be traced in the splendid series of specimens now preserved in the British Museum, all obtained from the same locality and the same horizon, no reasonable doubt can be entertained that the variation in question is of a comparatively trivial character, affecting the individual independently, and that it is not stamped by correlation with other structural modification with sufficient importance to justify the forms being separated from the species, or even a name being given to the variety. All the examples referred to in the foregoing remarks and figured in the plates accompanying this Memoir are from the Upper Chalk, and were obtained from the same locality near Bromley.

The fine specimen with large and greatly produced ultimate plates drawn on Pl. XI, fig. 2 *a*, is also an example of the second variation in the structure of this species, to which I have alluded. This manifests itself in the presence of an

additional supero-marginal plate. It will be seen that there are nine supero-marginal plates, exclusive of the terminals (or so-called oculars) on each side of the pentagonal disk. At first sight the presence of this odd intermediate marginal plate in association with the strikingly modified ultimate plates found in this example would appear sufficient to indicate a well-marked variety, if not actually a distinct species. A careful examination of the collection in the British Museum shows, however, that this assumption is untenable, for in another example (which bears the Museum number " 46,765 "), which also possesses an odd intermediate marginal plate on two of its sides, the ultimate plates are in no way specially abnormal in their form or size. The presence of the additional supero-marginal plate would in this case, therefore, appear to be only an occasional variation, and, so far as I am able to detect, occurring independently of other structural modifications. I have observed no differences either in the proportions or the ornamentation of the intermediate marginal plates worthy of remark. This view is strengthened, if not absolutely confirmed, by the presence in another specimen (British Museum number " 46,796 "), drawn on Pl. XII, fig. 1 *a*, of nine supero-marginal plates on two sides only of the disk, the remaining three sides having the normal number of eight marginal plates. In this example the ultimate plates are distinctly larger and more produced than in the truly normal forms of the species, but it will be noticed that their development is unequal, as is also the case in No. " 46,765 ; " in other words, in three of the rays one of the ultimate plates is smaller than the corresponding ultimate plate to which it is adjacent. The two sides which have an additional marginal plate are also the sides which have one of the smaller ultimate plates, and the inference naturally follows that the additional plate is to balance or compensate for the smaller size of the ultimate plate ; and I am inclined to think that the additional plate is not in this case a true *odd interradial* marginal plate at all, such as occurs in *Gnathaster*, Sladen, but that it is only a supplementary plate formed because its primitive or embryonic rudiment has not been included in the series merged together during development to form the structurally compound ultimate plate. That these ultimate plates are compound, or formed by the union of several embryonic plates, there is in my opinion little doubt when regard is had to the embryonic history of the ultimate plate and the associated infero-marginal plates.

2. Metopaster Mantelli, *Forbes*, sp. Pl. XIII, figs. 2 *a*—4 *b*.

Pentagonaster semilunatus,	*Parkinson*, 1811. Organic Remains of a Former World, vol. iii, p. 3, pl. i, fig. 1 (*non* Linck).
? Goniaster semilunata,	*Mantell*, 1844. The Medals of Creation, London, vol. i, p. 338, lign. 75 (*non* Linck, ? *nec* Parkinson).
Goniaster (Goniodiscus) Mantelli,	*Forbes*, 1848. Memoirs of the Geological Survey of Great Britain, vol. ii, p. 472.
— — —	*Forbes*, 1850. In Dixon's Geology and Fossils of the Tertiary and Cretaceous Formations of Sussex, London, 4to, p. 332, pl. xxiii, figs. 11, 12.
— — —	*Morris*, 1854. Catalogue of British Fossils, 2nd ed., p. 81.
? — Mantelli,	*Mantell*, 1854. The Medals of Creation, London, 2nd ed., vol. i, p. 307, lign. 98.
Astrogonium Mantelli,	*Dujardin and Hupé*, 1862. Hist. Nat. Zooph. Échin. (Suites à Buffon), p. 399.
Goniaster (Goniodiscus) Mantelli,	*Forbes*, 1878. In Dixon's Geology of Sussex (new edition, Jones), p. 366, pl. xxvi, figs. 11, 12.

Body of medium or rather small size. General form depressed. Abactinal surface flat, with the area circumscribed by the supero-marginal plates plain and rather sunken below the level of the median convexity of the border formed by these plates. Actinal surface plain, or may be a little convex in consequence of a tendency to a slight upturning of the rays in some examples. Marginal contour pentagonal, with sides faintly lunate, or in small examples they may be almost straight. The major radius measures scarcely one-third more than the minor radius. Margin rather thin, but well rounded.

The supero-marginal plates are four in number, counting from the median interradial line to the extremity, or eight from the tip of one ray to the tip of the adjacent ray, exclusive of the odd terminal or "ocular" plate in each case. In one example, which is figured by Forbes in Dixon's 'Geology of Sussex,'

there would appear to be only seven plates on the entire side, but only one radial angle is preserved intact, and much displacement of plates has occurred. The circumstance is in any case of comparatively trifling importance. The supero-marginal plates form a conspicuous and moderately broad border to the abactinal area of the disk, of uniform breadth throughout, and measuring about 6 mm. at the median interradial line in an example whose minor radius measures about 25 mm.

Excepting the ultimate paired plate all the supero-marginal plates are nearly subequal in size; the plates, however, adjacent to the median interradial line are slightly longer in relation to their breadth than those adjacent to the ultimate paired plate. The plates adjacent to the median interradial line have the appearance of being nearly square in outline as seen from above, the actual dimensions in the specimen under notice, whose side measures 38 mm., being length 5 mm., and breadth 6 mm. In a smaller example, with a side measurement of 29·5 mm., the corresponding plate is 3·5 mm. long and 4·5 mm. broad. In Forbes's type the measurements are, length 3·75 mm., and breadth 5 mm.

The abactinal surface of the supero-marginal plates is slightly tumid, and the general surface of the whole series forms a well-rounded regular curve from the adcentral margin to the margin in the lateral wall adjacent to the infero-marginal plates. The height of the plates as seen in the margin is less than their length, the actual measurement being about 3 mm. Their abactinal contour is distinctly convex, but not gibbous. The whole superficies of the plates is covered with small, widely spaced, equidistant, uniform punctations. In some examples which have been subjected to much weathering the punctations are almost obliterated, as in the case of the fine specimen shown on Pl. XIII, fig. 2 *a*. A narrow depressed border surrounds the margin of the plate, bearing very small, closely crowded punctations, those adjacent to the main or median area being in serial arrangement. Occasionally a small entrenched pedicellaria may be detected on the median area of the plate (see Pl. XIII, fig. 2 *b*).

The ultimate paired plate is small and triangular in outline as seen from above, and one margin touches the corresponding plate of the adjacent side of the disk throughout, the junction coinciding with the median radial line of the disk. The length of the plate—that is to say, of the side of the plate which falls in the margin of the disk—is a trifle greater than the length of the largest supero-marginal plate, measuring in the example under notice nearly 5·5 mm., whereas the breadth of the plate, or measurement of the side adjacent to the penultimate supero-marginal plate, is not more than 5 mm. Near the outer or apical extremity of this plate when seen from above there is frequently a more or less strongly developed tendency to gibbosity present.

The abactinal area of the disk within the boundary of the marginal plates is

covered with small subregular hexagonal plates or paxillar tabulæ, which are, however, comparatively large for the size of the species. The primary apical plates are large and conspicuous, and all the plates in the central area of the disk and in the interradial areas are considerably larger than elsewhere; all diminish in size as they approach the margin of the disk. All the plates have their surface covered with a small, uniform, closely placed granulation, in which an indefinite subcircular arrangement in relation to the centre of the plate is discernible (see Pl. XIII, fig. 2 *d*).

The madreporiform body is small and subtriangular in outline; its surface is sculptured by fine striations which radiate from the centre to the margin. The madreporite is usually enclosed by three plates, but four may be present in consequence of the division or retarded development of one of them, as is the case in the example figured on Pl. XIII, fig. 2 *c*. The position of the madreporite is rather nearer the centre of the disk than the margin.

The infero-marginal plates are at least six in number, counting from the median interradial line to the extremity,—that is to say, there are twelve (or perhaps more) for the whole side of the disk, as against eight in the supero-marginal series. The length of the three innermost plates on each side of the median interradial line is equal to that of the superior series, but there are three infero-marginal plates corresponding to the ultimate paired supero-marginal. As seen in the lateral wall of the disk, the height of the infero-marginal plates is greater than that of the supero-marginal series. The breadth of these plates, adjacent to the median interradial line on the actinal surface, is 5 mm. in an example whose minor radius measures about 15 mm. The breadth of the marginal border appears to be well maintained till near the extremity. The surface of the plates is ornamented in a similar manner to that of the supero-marginal plates, excepting that the punctations on the main area are rather more numerous, and that the finely punctate depressed border round the margin of the plate is much broader than in the plates of the superior series; the border is broader on the adcentral margin of the plate than elsewhere. (Compare figs. 3 *b* and 4 *b* on Pl. XIII.)

The adambulacral plates appear to be comparatively small, but their preservation in the examples examined is not sufficiently good to permit of description.

The actinal intermediate plates, which are small and hexagonal, are covered with small, closely crowded, uniform granules. All are much displaced in the specimens under notice.

Dimensions.—In the example figured on Pl. XIII, fig. 2 *a*, the major radius is about 32 mm., and the minor radius about 25 mm. The length of the side is 38 mm. The thickness of the margin is about 8 mm. In Forbes's type (Pl. XIII, fig. 3 *a*) the major radius is about 20 mm., and the minor radius about 15·5 mm.;

the length of the side about 25·5 mm. In a very finely preserved cast from the Upper Cretaceous beds of Haldon the length of the side is 29·5 mm.

Locality and Stratigraphical Position.—All the examples of this form with which I am acquainted are from the Upper Chalk. One of Forbes's type is from Gravesend, but the locality of the other is not recorded. The large example figured on Pl. XIII, fig. 2 *a*, is from the Upper Chalk near Bromley.

An extremely well-preserved cast in flint from the Upper Cretaceous beds of Haldon (Devonshire) is in the collection of the Albert Museum, Exeter; and a cast of this example may be seen in the Museum of the Geological Survey, Jermyn Street.

History.—This form appears to have been first recognised by Parkinson, who erroneously referred it to the *Pentagonaster semilunatus* of Linck. The latter is a well-known recent species, and quite distinct from the fossil under consideration. Mantell, following Parkinson's determination, referred to the form under the name of *Goniaster semilunata.* Forbes was the first to indicate that these views of his predecessors were incorrect, and diagnosed the species in his memoir 'On the Asteriadæ found fossil in British Strata' under the name of *Goniaster* (*Goniodiscus*) *Mantelli;* and figures of two examples were subsequently given in Dixon's 'Geology and Fossils of the Tertiary and Cretaceous Formations of Sussex,' London, 1850. Both these specimens are now preserved in the British Museum. Careful drawings of each fossil are given on Pl. XIII, figs. 3 *a* and 4 *a*.

Remarks.—It is not without hesitation that I maintain this species of Forbes's as independent from *Metopaster Parkinsoni.* For the present, however, I consider it to be distinguished by the smaller size, the comparative squareness of the supero-marginal plates, the small size of the ultimate paired plates, as well as by the character of the ornamentation of the supero-marginal plates and of the abactinal plates. Whether a more extensive series of specimens will break down or uphold these distinctions I do not feel prepared to say. It is undoubted that the two forms are very nearly allied.

I feel considerable doubt as to whether one of Forbes's types—that shown in Pl. XIII, fig. 4 *a*—really belongs to the same species as the examples illustrated in figs. 2 *a* and 3 *a* on the same plate.

3. Metopaster Bowerbankii, *Forbes*, sp. Pl. XV, figs. 2 *a*—2 *d*; Pl. XVI, figs. 1 *a*—1 *d*.

Goniaster (Goniodiscus) Bowerbankii,	*Forbes*,	1848. Memoirs of the Geological Survey of Great Britain, vol. ii, p. 473.
— — —	*Forbes*,	1850. In Dixon's Geology and Fossils of the Tertiary and Cretaceous Formations of Sussex, London, 4to, p. 333, pl. xxii, fig. 4.
— — —	*Morris*,	1854. Catalogue of British Fossils, 2nd ed., p. 81.
Astrogonium Bowerbankii,	*Dujardin and Hupé*,	1862. Hist. Nat. Zooph. Échin. (Suites à Buffon), p. 399.
Goniaster (Goniodiscus) Bowerbankii,	*Forbes*,	1878. In Dixon's Geology of Sussex (new edition, Jones), p. 366, pl. xxv, fig. 4.

Body of medium or rather large size. General form depressed. Abactinal surface flat; actinal surface also flat, or with a slight tendency to become convex. Marginal contour pentagonal, with a very small amount of lunation in the sides. Margin thick and well rounded.

The supero-marginal plates are five in number counting from the median interradial line to the extremity, or ten from the tip of one ray to the tip of the adjacent ray, exclusive of the odd terminal or "ocular" plate in each case. They form a broad border to the abactinal area of the disk of uniform breadth throughout, which measures about 8·5 mm. at the median interradial line in the type-specimen described by Forbes from the collection of the late Dr. Bowerbank. Excepting the ultimate paired plate all the supero-marginal plates are of equal size. They are short and broad, the breadth being nearly twice and a half the length, the actual measurements in the type being length 3·5 mm. or a trifle more, and breadth 8·5 mm., in which case the dimensions are in the proportion of 7 : 17. The abactinal surface of the plates is slightly convex along the direction of the breadth, sufficient to define each plate distinctly. The general surface of the whole series is gently arched towards the margin adjacent to the infero-marginal plates. The height of the plates as seen in the margin is about 6 mm., and there is scarcely any or only the slightest diminution in height as the plates approach

the extremity of the ray, and the ultimate paired plate is not prominent or gibbous abactinally. The whole superficies of the supero-marginal plates is covered with small, widely spaced, equidistant, uniform punctations, and along the entire margin of the plate is a very narrow and deeply depressed border of fairly uniform breadth, covered with much smaller and closely crowded punctations, upon which much smaller granules than those which occupied the central area of the plate were originally borne. One or two or even three small entrenched pedicellariæ may be present on the central area of a plate, irregularly disposed.

The ultimate paired plate is triangular in form as seen from above. The margin or side which represents its length and coincides with the margin of the disk measures a little more than once and a half or nearly twice the length of the adjacent supero-marginal plates; and the margin representing the breadth of the plate which abuts on the penultimate supero-marginal plate is shorter than the margin of the latter plate. The remaining side of the plate which touches the corresponding ultimate plate of the adjacent side of the disk, and falls in the median radial line of the disk, is subequal to or even slightly shorter than the breadth of the preceding marginal plates. The ultimate plate in this species is not elongated, and no prolongation beyond the normal pentagonal contour of the disk occurs in the extension of the median radial line. The surface of the ultimate plate is covered with punctations and margined with a finer and closely crowded series precisely similar to those on the other supero-marginal plates.

The abactinal area of the disk within the boundary of the marginal plates is covered with small, subregular, hexagonal plates or paxillar tabulæ, which have their surface marked with minute, low, subhemispherical, and closely placed miliary granulations, which do not, however, extend quite to the margins of the plates. A number of the plates bear in the centre a rather large entrenched pedicellaria, consisting of a central foramen and normally two lateral fossæ, and there is usually a circular series of coalesced granules in which the fossæ are included, which imparts a very characteristic appearance to the organ in this species (see Pl. XVI, fig. 1 *d*).

The following description of the characters of the actinal area of the disk of this species is taken from an example preserved in the Museum of Practical Geology, Jermyn Street, and figures of which are given on Pl. XV, figs. 2 *a*—2 *d*.

The infero-marginal plates are eight in number counting from the median interradial line to the extremity,—that is to say, there are sixteen for the whole side of the disk, as against ten in the supero-marginal series. The length of the four innermost plates on each side of the median interradial line is slightly greater than that of the corresponding plates of the supero-marginal series; and there are four infero-marginal plates much smaller than those preceding, corresponding

to the ultimate supero-marginal plate. As seen in the lateral wall of the disk the height of the infero-marginal plates is slightly greater than that of the supero-marginal series. The breadth of these plates adjacent to the median interradial line on the actinal surface is 6 mm., or even a little more in an example whose major radius measures 37 mm. and the minor radius 27 mm. The breadth of the marginal border rapidly diminishes towards the extremity of the ray. The surface of the infero-marginal plates is ornamented with extremely small and closely crowded punctations, upon which traces of a minute, closely crowded, and uniform granulation are preserved here and there.

The adambulacral plates are small, about twice as broad as long, and their surface is traversed by about three ridges, bearing punctures, running parallel to the ambulacral furrow, upon which the spinelets composing the adambulacral armature were articulated. There were about five or six spinelets in each lineal series.

The mouth-plates are regularly triangular, about twice and a half as long as broad, and the two adjacent plates which constitute a pair form together a regular rhomboid or lozenge-shaped figure. Their surface is covered with small, crowded, rather coarse, irregularly disposed tubercles or granules (see Pl. XV, fig. 2 *d*).

The actinal intermediate plates are fairly large, and there is a distinct diminution in size towards the outer margin of the disk adjacent to the marginal plates. The plates adjacent to the adambulacral plates are pentagonal, but a subhexagonal or polygonal form elsewhere is the rule, with comparatively little irregularity. The surface of the actinal intermediate plates is entirely covered with very small equidistant punctations, upon which a uniform close granulation was previously borne. Occasional small excavate pedicellariæ are present here and there, the lateral fossæ being slightly curved.

Dimensions.—The type specimen is unfortunately fragmentary, and the radial dimensions cannot be given. The length of one side of the disk, measured from the tip of one ray to the tip of the adjacent ray, is about 41 mm.; the breadth of the supero-marginal plates adjacent to the median interradial line is 9 mm.; and the thickness of the margin is about 12 mm.

In the fine example preserved in the Museum of Practical Geology, Jermyn Street, figured on Pl. XV, fig. 2 *a*, the major radius measures 37 mm., and the minor radius 27 mm.; the length of one side of the disk measured about 42 mm., or probably rather more when complete; the breadth of the infero-marginal plates adjacent to the median interradial line is 6 mm.; and the thickness of the margin is 8·5 mm.

Locality and Stratigraphical Position.—The type specimen is stated by Forbes

to have been obtained from the Upper Chalk of Kent, but no indication of locality is now preserved on the label. The example belonging to the Museum of Practical Geology is from the Upper Chalk of Gravesend.

History.—The type of this species, which was described by Forbes in his memoir 'On the Asteriadæ found fossil in British Strata' ('Mem. Geol. Surv.,' vol. ii, p. 473, 1848), originally formed part of Dr. Bowerbank's Collection, and was first figured by Forbes in Dixon's 'Geology and Fossils of the Tertiary and Cretaceous Formations of Sussex,' London, 1850, pl. xxii, fig. 4. That specimen is now preserved in the British Museum, where it bears the register number "E 2578." An accurate drawing of the type is given on Pl. XVI, fig. 1 *a*, of the present work.

4. Metopaster zonatus, *Sladen.* Pl. XII, figs. 2 *a*—2 *c*.

Body of small or medium size. General form depressed. Abactinal surface in the fossil condition, as at present known, essentially concave in consequence of the conspicuously upturned extremities of the rays. Actinal surface conformably convex. Marginal contour pentagonal, with the radial angles slightly produced and obtusely rounded, and the sides distinctly lunate. The major radius measures nearly one-half more than the minor radius, or in the proportion of 3 : 2 approximately; the actual dimensions in the example under notice being R = 27 mm., r = 19 mm. approximately. Margin very thick in relation to the size of the disk, and regularly rounded.

The supero-marginal plates are four in number, counting from the median interradial line to the extremity, or eight from the tip of one ray to the tip of the adjacent ray, exclusive of the odd terminal or "ocular" plate in each case. They form a broad border to the abactinal surface of the disk, of uniform breadth throughout, which measures about 8 mm. at the median interradial line, in an example whose minor radius measures 19 mm. Excepting the ultimate paired plate all the supero-marginal plates are subequal, the breadth being nearly three times the length, the actual measurements in the example under notice being length 2·75—3 mm., and breadth about 8 mm. The abactinal surface of the plates is distinctly convex along the median line of breadth, by which means each plate is conspicuously defined. The general surface of the whole supero-marginal series between the two ultimate plates is regularly rounded, and forms an uninter-

rupted regular curve between the adcentral margin of the plate and the margin in the lateral wall adjacent to the infero-marginal plates. The height of the plates as seen in the lateral view of the disk is greater than their length, and there is an apparent increase in height as the plates approach the extremity of the ray, the ultimate plate being still higher and distinctly tumid (see Pl. XII, fig. 2 *b*). The whole superficies of the plates is covered with small, widely spaced, equidistant, uniform punctations; and there is a narrow depressed border surrounding the margin of the plate with much smaller and closely crowded punctations, upon which minute miliary granules were previously borne.

The ultimate paired plate is much larger than any of the other supero-marginal plates, its length as measured on the outer margin being more than twice the length of the other supero-marginal plates. Its breadth is about equal to that of the adjacent supero-marginal plate. It is subtriangular in form as seen from above, and the line of junction with the corresponding companion plate of the adjacent side of the disk is complete throughout, and coincides with the median radial line. The convexity of the plate falls in a line parallel and adjacent to this margin of the plate, and its height is greatest there. From this convexity the surface slopes gradually and regularly in conformity to the curve of the superficies of the other supero-marginal plates. The actual dimensions of the ultimate plate in the example under notice are, length 7 mm., breadth 7 mm.; greatest height as seen in the marginal view, about 8·5 mm. The surface of the ultimate plate is marked with a precisely similar ornamentation to that on the other supero-marginal plates.

The odd terminal plate is very small, and though only traces are present in the type it is well preserved in other examples. It is prominent, cylindrical, and abruptly truncate, resembling in all respects the form described in *Metopaster Parkinsoni*.

The madreporiform body, which is only partially exposed in the example under notice, is apparently subtriangular in outline, and is marked with very fine centrifugally radiating striations (see Pl. XII, fig. 2 *c*).

The infero-marginal plates are seven in number, counting from the median interradial line to the extremity,—that is to say, there are fourteen for the whole side of the disk, as against eight in the supero-marginal series. The length of the three innermost plates on each side of the median interradial line is subequal to that of the superior series, but their height as seen in the marginal view of the disk is much greater, the thickness of the whole margin, *i. e.* both series of plates together, being 10 mm. in an example whose minor radius is 19 mm. Four plates underlie the superior ultimate plate, the last two being very small and triangular in form. All the four are adjacent to the adambulacral series of plates. The ornamentation or surface-marking of the infero-marginal plates is precisely similar to that of the supero-marginal series.

Dimensions.—In the example figured on Pl. XII, fig. 2 *a*, the major radius is 27 mm. and the minor radius about 19 mm., the thickness of the margin 10 mm.

Locality and Stratigraphical Position.—The figured example is from the Upper Chalk near Bromley. A number of other examples of this species are in the collection of the British Museum, all from the Upper Chalk, and most of them from the same locality, the locality of the remainder being not recorded.

Remarks.—I was at first somewhat in doubt as to whether to rank this form as a variety of *Metopaster Parkinsoni*, or as a distinct species. I have taken the latter course. Although there are many points of resemblance in general structure, as well as in various details when considered independently, the facies of this form is so distinct from that of *Metopaster Parkinsoni*, and is so readily recognisable, that there seems to me full justification for considering *Metopaster zonatus* specifically distinct. The great breadth of the supero-marginal plates as compared with their length, the form and character of the ultimate plates, the great thickness of the margin, and the relative proportions of the marginal plates, as well as the general habit of the abactinal surface, apart either from the individual characteristics of the plates independently or from other special details, are amply sufficient to distinguish the form from its nearest ally, *Metopaster Parkinsoni*.

5. Metopaster uncatus, *Forbes*, sp. Pl. XI, figs. 3 *a*, 3 *b*; Pl. XIV, figs. 1 *a*—3; Pl. XV, figs. 1 *a*, 1 *b*.

Goniaster (Goniodiscus) uncatus, *Forbes*, 1848. Memoirs of the Geological Survey of Great Britain, vol. ii, p. 472.

— — — *Forbes*, 1850. In Dixon's Geology and Fossils of the Tertiary and Cretaceous Formations of Sussex, London, 4to, p. 331, pl. xxi, figs. 4, 5, 8.

— — — *Morris*, 1854. Catalogue of British Fossils, 2nd ed., p. 81.

Astrogonium uncatum, *Dujardin and Hupé*, 1862. Hist. Nat. Zooph. Échin. (Suites à Buffon), p. 399.

Goniaster (Goniodiscus) uncatus, *Forbes*, 1878. In Dixon's Geology of Sussex (new edition, Jones), p. 365, pl. xxiv, figs. 4, 5, 8.

Body rather small, or at most only of medium size. General form depressed. Abactinal surface flat, or with a tendency for the rays to be slightly directed upward at the extremities. Actinal surface slightly convex. Marginal contour pentagonal, with the sides slightly lunate, though the curvature is often more or less flattened; the extremity of the rays is only slightly produced. The major radius measures about one-third more than the minor radius, the major dimension being proportionately rather greater in large tests than in small ones. The margin is thick, and the lateral wall has more of a precipitous than a rounded character, although the infero-marginal plates are well rounded on the actinal surface.

The supero-marginal plates are three in number, counting from the median interradial line to the extremity, or six from the tip of one ray to the tip of the adjacent ray, exclusive of the odd terminal or "ocular" plate in each case. They form a broad border to the abactinal area of the disk, of uniform breadth throughout, which measures about 7 mm. at the median interradial line in an example whose major radius measures 36·5 mm. and minor radius 27 mm. (Pl. XIV, fig. 2 *a*). Excepting the ultimate paired plates, the four intermediate supero-marginal plates on each side of the disk are of equal size, the breadth being about once and a half the length, the actual measurements in the specimen under notice being length 5 mm., and breadth 7 mm. The abactinal surface of these plates is tumidly convex, while the lateral wall is plane and vertical, and the abactinal tumidity commences abruptly at a little distance from the adcentral margin of the plate, which leaves a small level area at the rounded end of the plate abutting on the abactinal plates or paxillar tabulæ. On the surface of this level band near the adcentral margin, and forming a more or less definite series running parallel to it, are three or four irregular tubercular eminences or granules, but very indistinct and more or less weatherworn (see Pl. XIV, fig. 2 *c*). The entire margin of the plate is surrounded by a very narrow depressed border, with very fine, closely crowded, uniserially disposed punctations, upon which a small miliary granulation was previously borne. The whole general superficies of the plate is smooth and weatherworn in every example I have seen. The height of the plates as seen in the margin is as great as or even slightly greater than their length, and the prominently tumid character of the plates abactinally causes them to appear in the lateral view somewhat like truncate cones abruptly rounded (see Pl. XIV, fig. 2 *b*).

The ultimate paired plate is larger and longer than any of the other plates, and is of a different and very peculiar shape. It is subtriangular in form as seen from above, produced and pointed at the extremity, and to a certain extent recalls the form of a ploughshare or coulter in consequence of a peculiar nipped-in appearance caused by the extension of a tumid region which runs parallel to the

outer margin and rises abruptly from a level area which occupies the inner half of the plate along the margin touching the corresponding plate of the adjacent ray, —the line of junction of the two plates coinciding with the median radial line. The length of the ultimate plate is nearly twice that of the other marginal plates, measuring 9·25 mm. in an example whose major radius is 36·5 mm. and minor radius 27 mm. As seen in the marginal view of the test, the ultimate is not higher or more tumid than the other marginal plates (see Pl. XIV, fig. 2 *b*). The outer margin of the ultimate plate has a slight concave curvature, and the inner margin adjacent to the corresponding plate is curved convexly towards the proximal end of the plate. In consequence of this rounding the two ultimate plates in a pair do not unite throughout their entire length, but are separated by a small notch at the end of the suture adjacent to the abactinal paxillar area of the disk. On the small level area of the ultimate plate are a number of small irregular tubercular eminences; four or five larger than the others form a sort of series parallel to the rounded margin, and a longitudinal series of eight or nine much smaller miliary granules run along the flank of the longitudinal tumidity of the plate; and several additional granules of intermediate size may be present in the space between the two series just described. Excepting these granules, the surface of the ultimate plate is smooth like that of the other supero-marginal plates.

The abactinal area of the disk within the boundary of the marginal plates is covered with small subregular plates or paxillar tabulæ, an hexagonal form predominating. The plates in the median interradial areas are much larger than the other plates on the disk, and a marked diminution in size in all the plates takes place as they approach the margin. All the plates have their surface marked with a very fine granulation. Small entrenched pedicellariæ are occasionally present, but there appear to have been very few.

The primary basal plates are larger than any of the other abactinal plates. They are well seen in an example from the Upper Chalk of Kent, in which the inner side of the abactinal wall is exposed by the removal of the actinal floor and ambulacral plates. This specimen, which is preserved in the British Museum, and bears the registration number "35,496," is drawn on Pl. XI, fig. 3 *a*. The example in question is further interesting in showing that the plates of the radial regions have stellate bases, whereas the larger plates of the interradial regions are sharply hexagonal, and fit closely to their adjacent plates (see fig. 3 *b*).

The madreporiform body is very small, and is subsagittiform or irregularly lozenge-shaped in outline; in the example under notice it is embedded, all except two straight sides, in one large adcentrally placed basal plate (see Pl. XIV, fig. 2 *d*); the two straight sides are bounded each by one large plate. The surface of the madreporite is sculptured by very fine striations, which though more or less wavy are directed subparallel to the adcentral sides of the body.

The position of the madreporite is nearer the centre of the disk than the margin.

The infero-marginal plates are six in number, counting from the median interradial line to the extremity,—that is to say, there are twelve for the whole side of the disk, as against six in the supero-marginal series. The length of the two innermost plates on each side of the median interradial line is subequal to that of the superior series, but the four succeeding infero-marginal plates are much shorter, and together correspond to the large ultimate supero-marginal plate. As seen in the lateral wall of the disk the height of the infero-marginal plates is very little more than one-half that of the superior series, the actual proportion in the specimen under notice being less than three-fifths. The breadth of the plates adjacent to the median interradial line on the actinal surface is 7·5 mm. in an example whose major radius measures 25 mm. and the minor radius 20 mm. The breadth of the marginal border diminishes so rapidly on each side of the median interradial line towards the extremities of the rays that the inner margin of the series of infero-marginal plates of each side of the disk is practically a sector of a circle. The surface of the plates is marked with small widely spaced punctations, and there is a narrow depressed border round the entire margin of the plate which is very finely punctate; the border is broader at the adcentral end of the plate and the adjacent corners than elsewhere.

The adambulacral plates are small, broader than long, and their surface is marked with about three oblique series, and an outer irregular group of fine punctations upon which the spinelets composing the armature of the plates were articulated. There are about six punctations in the innermost ridge or series adjacent to the ambulacral furrow. A few spinelets are still preserved in an example from the Upper Chalk near Bromley, from which this description is taken, which is in the British Museum collection, and bears the registration number, "E 2613." The spinelets are cylindrical, truncated, and do not appear to taper; and their length is about equal to the length of the plates.

The actinal intermediate plates are rhomboid and hexagonal or polygonal in form, and their surface is entirely covered with small equidistant punctations, upon which small uniform granules were previously attached. Remains of this granulation are occasionally to be found preserved *in situ*, and may be seen in the example referred to in the preceding paragraph. Small entrenched pedicellariæ are occasionally present on the actinal intermediate plates.

Dimensions.—The example figured on Pl. XIV, fig. 2 *a*, has a major radius of 36·5 mm. and a minor radius of 27 mm. The length of the side is about 40 mm. Another specimen, shown in fig. 1 *a* on the same plate, is rather larger, the length of the side being about 45 mm. Much displacement of the plates has occurred in

this fossil, and the radial dimensions can only be calculated approximately. The specimen figured by Forbes, which I have unfortunately not been able to trace, is smaller than either of the above. The drawing represents a test with the major radius measuring about 25 mm., the minor radius 20 mm., and the length of the side about 28 mm. The figure of the actinal aspect of this example is reproduced on Pl. XIV, fig. 3, of this memoir.

Locality and Stratigraphical Position.—This is a well-known Upper-Chalk form. It is recorded by Forbes from Kent, Sussex, and Wiltshire. Specimens in the British Museum bear the localities of Charlton, Gravesend, Bromley, and "Kent."

History.—This species, primarily described by Forbes in his memoir 'On the Asteriadæ found fossil in British Strata,' was first figured in Dixon's 'Geology and Fossils of the Tertiary and Cretaceous Formations of Sussex,' London, 1850. The example which I consider must undoubtedly have been the type (Dixon, pl. xxi, figs. 4 and 5) I have hitherto unfortunately not been able to find. It is stated by Forbes to have formed part of the late Mr. Pearce's collection, and to have been obtained from the Wiltshire Chalk. A badly drawn fragment (Dixon, pl. xxi, fig. 8) is preserved in the British Museum, but I do not consider it to be correctly referred to this species. In my opinion it belongs to a distinct species, *Metopaster cingulatus*, of which a description is given at p. 53.

The examples of this species which have been drawn on Pl. XIV are preserved in the British Museum.

6. Metopaster sublunatus, *Forbes*, sp.

Goniaster (Goniodiscus) sublunatus,			*Forbes*, 1848. Memoirs of the Geological Survey of Great Britain, vol. ii, p. 472.
—	—	—	*Forbes*, 1850. In Dixon's Geology and Fossils of the Tertiary and Cretaceous Formations of Sussex, London, 4to, p. 331.
—	—	—	*Morris*, 1854. Catalogue of British Fossils, 2nd ed., p. 81.
Astrogonium sublunatum,			*Dujardin and Hupé*, 1862. Hist. Nat. Zooph. Échin. (Suites à Buffon), p. 399.
Goniaster (Goniodiscus) sublunatus,			*Forbes*, 1878. In Dixon's Geology of Sussex (new edition, Jones), p. 365.

This species was described by the late Professor Edward Forbes in Dixon's 'Geology of Sussex' in 1850 in the following words:

"Body pentagonal, with gently lunated sides. Superior intermediate marginal plates four, nearly equal, plain, smooth, or minutely punctate. Inferiors similar. Superior oculars mitrate, large, triangular, acuminated. Ossicula of disc punctate.

"Easily distinguished from the last species [*uncatus*] by its flattened marginals and from the next [*Hunteri*] by its lunated sides.

"Mus. Bowerbank, from the white chalk; also in the collection of the Geological Survey" (op. cit., p. 331).

No figure of the species has ever been published, and no record exists as to the specimen or specimens seen or used by Forbes as type. I have been unable to find any example from the Bowerbank Collection to which this name has been or can be applied; and the only examples which I have seen referred to this species at all are four fragmentary specimens now preserved in the Museum of the Geological Survey in Jermyn Street, and not more than two of these could have been in that collection in 1850.

After a careful study of these specimens I am bound to confess that I find no character by which they can be separated from *Metopaster uncatus;* and if the diagnosis is correct I am led to consider that I have certainly not seen Forbes's type. The *supero*-marginal plates in the specimens in question are *not* flattened, and cannot be said to differ in character from those of *Metopaster uncatus*.

A possible explanation suggests itself in the supposition that Forbes inadvertently mistook the actinal for the abactinal surface of the disk, a mistake which might easily be made by a less careful observer than the author of this species when dealing with a badly preserved fragment. If, however, what is really the actinal surface has been described as the abactinal surface the difficulty is practically solved, for the infero-marginal plates in the fragments under notice *are* "plain, smooth, or minutely punctate." That this is not an improbable explanation I would submit the following facts:—(1) that in the original diagnosis of 1848[1] Forbes states that the infero-marginal plates are unknown; (2) that in the diagnosis of 1850, given above, the infero-marginal plates are stated to be "similar" (to the supero-marginals); and (3) that notwithstanding these statements all the examples in the Geological Survey Collection are essentially actinal presentments of the disk, and therefore the infero-marginal plates are the plates

[1] The following is the diagnosis in full:—"G. corpore pentagonali, lateribus lunatis; *ossiculis lateralibus superioribus* 4, subæqualibus, planis, minutissime punctatis; *inferioribus? Ossiculis ocularibus superioribus* magnis, triangularibus, mitratis, tumidis, acuminatis." ('Mem. Geological Survey of Great Britain,' vol. ii, p. 472.)

conspicuously available for description. To my mind it follows with little doubt either that Forbes has described the infero-marginal plates as supero-marginals, or else that I have not seen his type specimens.

With my reverence for all that Forbes has written I prefer to leave the species as described by him, together with the record of these remarks, rather than strike a ruthless pen through any species created by so careful and accurate a worker. Time will pronounce the verdict.

I consider it quite unnecessary to figure any of the fragments, here referred to, as being in the Jermyn Street Collection. The differences they present as compared with a series of *Metopaster uncatus* do not in my opinion amount to even varietal rank, and are confined to the slightly less developed tumidity of the abactinal surface of the supero-marginal plates, and to the external contour of the mitrate ultimate paired supero-marginal plates, which is slightly convex marginally rather than incurved to produce the characteristically claw-shaped form of *Metopaster uncatus*. These are, in my opinion, merely individual differences.

7. Metopaster cingulatus, *Sladen*. Pl. XIV, figs. 4 *a*—4 *d*.

Body of small size. General form depressed. Abactinal surface slightly concave, actinal surface flat. Marginal contour pentagonal, with the sides slightly lunate. The rays are not produced beyond the contour of a true pentagon, and the radial angles are not rounded. The major radius is proportional to the minor radius as 100 : 77·5, the actual dimensions in the example described being, major radius 20 mm., minor radius 15·5 mm , approximately. The margin is thick, and though well rounded has more or less of a precipitous character.

The supero-marginal plates are three in number, counting from the median interradial line to the extremity, or six from the tip of one ray to the tip of the adjacent ray, exclusive of the odd terminal or "ocular" plate in each case. They form a broad border to the abactinal area of the disk of uniform breadth throughout, which measures about 6·5 mm. at the median interradial line in an example whose diameter (R + r) measures from about 36 mm. to 37 mm.

Excepting the ultimate paired plates, the four intermediate supero-marginal plates on each side of the disk are approximately equal in size, the breadth being more than twice and a half the length, the actual dimensions in the example under notice being length 2·25 mm., and breadth 6·5 mm., in the plate adjacent to the median interradial line. The abactinal surface of these plates is distinctly tumid, a subtubercular eminence rising in the median third of the abactinal area of the plate. The slope of the tumidity descends gradually on the outer side, and

merges in the rounding of the high lateral wall of the plate. On the level area of the plate, which is consequently the inner or adcentral part of the surface, are several low tubercular eminences of irregular shape and disposition, but which appear to assume a more or less distinct biserial arrangement at right angles to the adcentral margin of the plate. They appear to be enlarged irregular granules, and in all the examples I have examined they have become to a certain extent ill-defined, owing either to growth or to weather-wearing. The general character of the ornamentation is shown in Pl. XIV, fig. 4*c*. The entire margin of the plate is surrounded by a very narrow depressed border, which is very minutely punctate, probably only in a single lineal series. The general superficies of the plate beyond the ornamentation mentioned is smooth, as if weatherworn, in all the examples I have seen, but in some specimens there appear to be traces of a more or less granulous character, and in some instances suggest the impression that an ornamentation similar to that noticed in *Mitraster rugatus* was probably present on at least a part of the surface of the plate. The height of the supero-marginal plates as seen in the margin is greater than their length, and their prominent abactinal tumidity has a distinctly conical character from this point of view.

The ultimate paired plate is fully twice as long as the other supero-marginal plates measured on the outer margin, and its breadth is equal to that of the adjacent supero-marginal. It is triangular in form, and the line of junction with the companion ultimate plate of the adjacent side coincides with the median radial line. The actual dimensions in the example under description are, length 6·2 mm., breadth about 6 mm. As seen in the lateral view of the disk the ultimate plates are distinctly tumid abactinally (see Pl. XIV, fig. 4*b*). The abactinal surface of the plate is ornamented by a number of miliary tubercles or granules, more or less serially disposed parallel to the margin adjacent to the companion plate, and more numerous at the adcentral end of that margin. Beyond this the surface of the ultimate plate is smooth, like that of the other supero-marginal plates.

The abactinal area of the disk within the boundary of the marginal plates is covered with hexagonal or polygonal plates or paxillar tabulæ, which are small in size generally, excepting the primary apical plates, which are comparatively very large. All the plates have their surface covered with a fine, uniform granulation. The primary apical plates have a small central area of low elevation, not higher than if a number of granules had become coalesced—the structure being suggestive of a tubercle in process of disappearance,—in other words, the scar left by a tubercle which had existed in an earlier stage of growth (see Pl. XIV, fig. 4*d*).

Dimensions.—The example figured on Pl. XIV, fig. 4*a*, has the following

measurements:—major radius, 20 mm.; minor radius, 15·5 mm; length of the side, about 22 mm. The thickness of the margin is 7 mm. in a specimen whose side is 23·5 mm.

Locality and Stratigraphical Position.—The specimen described above and figured on Pl. XIV, fig. 4 *a*, is from the Upper Chalk, near Bromley. It is preserved in the British Museum, and bears the register-number "46,776." Other examples which I refer to the same species are also in the National Collection, and one, if not more, was obtained from the same locality.

Remarks.—A fragmentary example which was figured in Dixon's 'Geology and Fossils of the Tertiary and Cretaceous Formations of Sussex,' pl. xxi, fig. 8, and was referred by Forbes to *Goniaster* (*Goniodiscus*) *uncatus*, now forms part of the collection in the British Museum, and bears the registered number "E 2577." This specimen appears to me to belong to the present species, and not to the true *Metopaster uncatus*. I can scarcely think that Forbes would have intentionally ranked the two forms as belonging to one species, and I have not thought it needful on the sole grounds of this fragment having been figured to regard *Metopaster cingulatus* as a dismemberment of Forbes' *Metopaster uncatus*.

Metopaster cingulatus is readily distinguished from *Metopaster uncatus* by its very short broad supero-marginal plates, by their more limited and more conical tumidity, by their greater height as seen in the margin, as well as by their different ornamentation. The ultimate plates are triangular, and do not present the peculiar form characteristic of *Metopaster uncatus*. In many respects *Metopaster cingulatus* appears to hold an intermediate position between *Mitraster rugatus* and *Metopaster uncatus*.

8. Metopaster cornutus, *Sladen*. Pl. XIV, figs. 5 *a*—5 *d*.

Body of small size. General form depressed. Abactinal surface slightly concave, the extremity of the rays being directed slightly upward. Actinal surface slightly convex. Marginal contour pentagonal, with the sides slightly lunate and the extremity of the rays slightly produced. The major radius is proportional to the minor radius as 100 : 74, the actual dimensions in the example described being, major radius about 19 mm., minor radius about 14 mm. approximately. The length of the side is 22·5 mm. The margin is moderately thick and apparently well rounded.

The supero-marginal plates are only two in number, counting from the median interradial line to the extremity, or four from the tip of one ray to the tip of the adjacent ray, exclusive of the odd terminal or "ocular" plate in each case. They form a broad border to the abactinal area of the disk. The supero-marginal plate adjacent to the median interradial line is broader than long, the dimensions in the example described being length about 3·25 mm., and breadth about 5·75 mm. The abactinal surface of this plate is slightly convex in the median line of breadth. The entire margin of the plate is surrounded by a very narrow depressed border with very minute punctations, closely crowded and uniserially disposed near the inner edge of the border, upon which a small miliary granulation was previously borne. The general superficies of the plate is covered with minute punctations irregularly disposed. The height of the two intermediate supero-marginal plates as seen in the lateral view of the margin (Pl. XIV, fig. 5 *b*) is scarcely half their length, and is less than half the height of the underlying infero-marginal plates.

The ultimate paired plate is very much larger than the small intermediate plate just described, being nearly three times as long, the actual measurement being about 9·25 mm. in the example under notice. It is of a peculiar form, being shaped somewhat like an irregularly formed elytron of an insect as seen from above, the proximal margin being truncate where it joins the companion intermediate plate, and the distal extremity obtusely rounded (Pl. XIV, fig. 5 *c*). At a point situated three-fourths of the distance from the proximal to the distal extremity rises an abrupt truncate teat-like eminence. The peculiar form of the plate as seen in the lateral view of the margin and the character of the eminence just described will be better appreciated by reference to Pl. XIV, fig. 5 *d*, than by verbal description. The superficies of the ultimate plate is studded with rather widely spaced punctations disposed in groups, which do not extend over the whole of the area which falls in the lateral wall of the disk. As seen in the marginal view of the test the ultimate is very much higher than the intermediate marginal plates (see Pl. XIV, fig. 5 *b*).

The odd terminal plate is unknown to me, no trace being preserved in the example under notice.

In like manner the whole of the abactinal plating within the boundary of the supero-marginal plates has been removed, excepting only a few isolated fragments of plates out of position.

The infero-marginal plates are large and high. Four are preserved between the median interradial line and the extremity, but the series is incomplete, probably one or more being wanting at the distal end of the series. This would increase the number eight now preserved on the whole side to ten or perhaps twelve. The two infero-marginal plates on each side of the median interradial

line are much larger and higher than the other plates. The plate adjacent to the median interradial line measures about 4 mm. in length and 4 mm. in height; the next plate 5 mm. in length, and from 3·5 mm. to 3·75 mm. in height. The surface of the plates is marked with small widely spaced punctations, and there is a narrow depressed border round the entire margin of the plate, which is very finely punctate.

The actinal area is unknown to me.

History.—The fossil delineated on Pl. XIV, fig. 5 *a*, was drawn by Mr. A. H. Searle under Dr. Wright's instructions, but I regret that I have not been able to find any trace of the specimen. I am therefore led to believe that the type belonged to Dr. Wright's private collection, which has been distributed since his lamented death. Knowing by experience the extreme care and fidelity which characterise all Mr. Searle's work, I have ventured to describe the species from his drawings alone, for it seemed undesirable to leave such an interesting form without notice; and I am hopeful that the publication of the figure and the description of its characteristic features will lead to the detection of the type. I am unable to give any information as to the locality or stratigraphical position from which the fossil was obtained.

Remarks.—The rather small size of this example and the small number of supero-marginal plates—only four for the whole side of the disk—would not unnaturally suggest at first sight that this was possibly an immature form. After careful study, however, I do not consider such to be the case, or at any rate I am unable to regard the fossil under notice as the young of any of the species with which I am acquainted. The large and characteristically developed ultimate supero-marginal plates in conjunction with the presence of a normal number of infero-marginal plates, together with the fact that the size of the test is not less than that of another perfectly characterised species, lead me to rank this as a distinct species with little hesitation. The general proportions as well as the character of the different plates, and the facies of the form as a whole, appear to me to fully warrant this view.

Genus—MITRASTER, *Sladen.*

(Μίτρα = a broad belt, or girdle.)

Body depressed and cycloid, or cyclo-pentagonoid in contour. Marginal plates with co-ordinated granulose elevations and punctations, and a surrounding narrow

depressed border with very minute punctations for the articulation of setæ. Supero-marginal plates few in number and all subequal in size, forming a broad uniform border to the disk. Abactinal area covered with polygonal plates, some of which may have stellate or substellate bases, and upon the tabulæ are borne small, more or less co-ordinated granules. Infero-marginal plates more numerous than the supero-marginal series, and decreasing in size as they approach the extremity; the surface marked with punctations, which may be co-ordinated in a similar manner to that of those on the supero-marginal series, and may be associated with granulose elevations. Actinal intermediate plates small, polygonal, covered with uniform, crowded, shallow punctations, upon which granules were originally borne. Armature of the adambulacral plates arranged in longitudinal lines, which may be slightly oblique. Small entrenched pedicellariæ may be present occasionally on the actinal intermediate plates.

Mitraster is characterised by its cycloid contour, by the equality in size of the supero-marginal plates, which do not diminish towards the extremity, and by the character of the ornamentation of the marginal plates, especially of the superior series.

The main characters which distinguish this and the two preceding genera are distinctly relative, and may be here conveniently compared. In *Pentagonaster* the rays are more or less produced, the supero-marginal plates are more or less numerous, and decrease in size as they approach the extremity of the ray, and are devoid of a marginal border of setæ. In *Metopaster* the rays are very slightly produced, the contour being pentagonal and only slightly extended. The supero-marginal plates are few in number, and do not decrease in size as they approach the extremity, the ultimate paired plate being larger than the others. All are furnished with a marginal border of setæ. In *Mitraster* the contour is cycloid almost to the obliteration of the pentagonal form. The supero-marginal plates are few in number, but neither decrease nor diminish in size, being subequal throughout; and they are furnished with a marginal border of setæ.

I consider that these differences indicate structural characters of sufficient morphological significance to render the forms presenting them worthy of recognition as distinct genera.

1. Mitraster Hunteri, *Forbes*, sp. Pl. IX, figs. 3 *a*—3 *e*; Pl. XII, figs. 3 *a*—3 *e*; Pl. XV, figs. 3 *a*—5 *b*.

Goniaster regularis,			*Mantell*, 1844. Medals of Creation, vol. i, p. 335, lign. 73 (*non* Linck).
Goniaster (Goniodiscus) Hunteri,			*Forbes*, 1848. Memoirs of the Geological Survey of Great Britain, vol. ii, p. 471.
—	—	—	*Forbes*, 1850. In Dixon's Geology and Fossils of the Tertiary and Cretaceous Formations of Sussex, London, 4to, p. 331, pl. xxi, fig. 1.
—	—	—	*Morris*, 1854. Catalogue of British Fossils, 2nd ed., p. 81.
Astrogonium Hunteri,			*Dujardin and Hupé*, 1862. Hist. Nat. Zooph. Échin. (Suites à Buffon), p. 399.
Goniaster (Goniodiscus) Hunteri,			*Forbes*, 1878. In Dixon's Geology of Sussex (new edition, Jones), p. 365, pl. xxiv, fig. 1.

Body of small size. General form depressed. Abactinal surface flat and apparently depressed within the boundary of the supero-marginal plates, the gibbosity of the latter and their centrally sloping surface giving a concave character to the area generally in fossil examples, which was probably always more or less present. Actinal surface flat or with a tendency to be slightly convex. Marginal contour subcircularly pentagonoid, the sides being slightly convex or bulging outward. The major radius is proportional to the minor radius as 100 : 90·47 approximately; and the rays are not produced, the angles of the pentagon being obtusely rounded. Margin thick and well rounded, the slope being more gradual on the actinal surface.

The supero-marginal plates are three in number counting from the median interradial line to the extremity, or six from the tip of one ray to the tip of the adjacent ray, exclusive of the odd terminal or "ocular" plate in each case. They form a broad border to the abactinal area of the disk, of uniform breadth throughout, which measures about 6·3 mm. at the median interradial line in an example whose diameter (R + *r*) measures about 40 mm. Excepting the ultimate plates all the supero-marginal plates are of equal size and uniform, the breadth being a little more than once and a half the length, the actual measurements in the

specimen under notice being length 4 mm. and breadth 6·3 mm., in the plate adjacent to the median interradial line. The length of the plate at the end which falls in the margin of the disk is a shade greater than the adcentral or inner end, and the plates are consequently faintly wedge-shaped, but so slightly that the character is scarcely noticed at first sight. The ultimate plates, however, are distinctly wedge-shaped, the length at the outer margin being a little greater than that of the other marginal plates, while the length of the inner end is rather less—often not more than one-half the length of the same end in the other plates. The breadth of the ultimate plates is the same as that of all the supero-marginal plates; and the corresponding plates of the two adjacent sides touch one another throughout, the line of junction falling in the median line of the ray. The abactinal surface of the plates is distinctly convex, and the character is more conspicuously emphasised by the plate becoming rapidly gibbous on the outer half, the outer side of the eminence forming the rapid bend to the lateral wall of the plate. The height of the plates as seen in the margin is usually equal to, or even rather greater than their length, but may occasionally be less. There is no diminution in height as the plates approach the extremity of the ray, and the ultimate paired plate has a tendency to appear even a trifle higher and more gibbous than the others, but the character is derived probably more from the position in which the plate sometimes is than from an actual increase in size or gibbosity. The abactinal surface of the plates is covered with coarse tuberculiform mammillations which gradually die out before reaching the apex of the gibbosity. In the interspaces between the eminences are small, more or less widely spaced punctations, and these extend over the whole surface of the plate, and are consequently present on the outer portions as well as on the lateral wall. There is a narrow depressed border round the entire margin of the plate, which is very minutely punctate (see Pl. XII, fig. 3 *c*). In smaller examples there often appears to be only one or two rows of punctations. The ornamentation of the ultimate paired plates is precisely similar to that on the other supero-marginal plates.

The odd terminal or "ocular" plate is very small, and, so far as I can make out, resembles superficially a short truncated cylinder which protrudes somewhat cannon-like from a small triangular space left by the ultimate paired plates similar to what I have already described in *Metopaster*.

The abactinal area of the disk within the boundary of the marginal plates is covered with comparatively large polygonal plates, with closely crowded, rather coarse, uniform granulations, upon which miliary granules or spinelets were previously borne. The primary apical plates are remarkably large, and the plates in the interradial areas are larger than the plates in the radial areas. Of the plates in the radial areas at least the median series and two series on each side have bases of a six-rayed, substellate form. These are admirably seen in an

example preserved in the British Museum bearing the register-number "46,772," in which the inner surface of the abactinal floor is exposed.

The madreporiform body, in the examples in which I have detected its presence, appears to be small and subtriangular, and is marked with very coarse striations.

The infero-marginal plates are five in number, counting from the median interradial line to the extremity,—that is to say, there are ten for the whole side of the disk as against six in the supero-marginal series. The length of the two innermost plates on each side of the median interradial line is a little greater than that of the corresponding superior plates; the breadth of the plate adjacent to the median interradial line is 7 mm. in the specimen bearing the British Museum register-number "46,766," and is a little greater than the breadth of the corresponding superior plate as seen in the example bearing the British Museum register number "E 2583."

The second plate, counting from the median interradial line, is a little less broad, and the third is slightly more diminished in breadth, and its adcentral margin merges with a sweeping curve into the lateral distal margin, which gives the plate a more or less cuneiform shape. A large portion of the distal lateral margin of this plate abuts on the adambulacral plates. The fourth infero-marginal plate is very small and triangular in form, with the apex directed adcentrally, and with one side abutting entirely on the adambulacral plates. The fifth plate is smaller still. In consequence of the triangular shape of the fourth and fifth plates the greatest length of the third plate is opposite the apex of the fourth plate, and the length of the third plate gradually diminishes up to the outer margin. The breadth of the third plate is 5·6 mm., and that of the fourth plate is only 3·2 mm.

The surface of the infero-marginal plates, which is more or less plain, is ornamented with small, widely spaced, and more or less equidistant punctations, and there is no trace of the tubercular mammillation present on the surface of the supero-marginal plates. On the inner third of the plate the punctations are more closely placed, and they have the appearance of falling into a more or less distinct reticulated arrangement (see Pl. XII, fig. 3 *d*). A narrow depressed border surrounds the entire margin of each plate, which is very minutely punctate.

The adambulacral plates, which are small, are broader than long, and have their surface traversed by several ridges placed slightly obliquely, but I am unable to define the armature.

The actinal intermediate plates, which are somewhat large in relation to the size of the disk, are rhomboid or polygonal in outline. Their surface is covered with small, closely crowded, uniform pits, upon which miliary granules or spinelets

were previously borne (see Pl. XII, fig. 3 *e*). A small entrenched pedicellaria may be present on an occasional plate here and there.

Dimensions.—The example figured on Pl. XII, fig. 3 *a*, has a major radius of about 30 mm., and a minor radius of about 28 mm. The length of the side is about 36 mm. The thickness of the margin is about 10 mm. In the specimen given on Pl. XV, fig. 4 *a*, the major radius measures 21 mm., and the minor radius 19 mm. approximately. The length of the side is about 25 mm.

Locality and Stratigraphical Position.—This species is a characteristic Upper Chalk form. The majority of examples are from Kent and Sussex. A fine series from Bromley is preserved in the British Museum.

History.—This species was referred to by Dr. Mantell under the name of *Goniaster regularis*. The specific name was, however, already preoccupied—at least in literature—for an existing starfish; and although the latter is not now recognisable, no doubt can possibly exist that Mantell's fossil species is certainly a different thing from the starfish to which Linck gave the name of *Pentagonaster regularis*.

Forbes was the first to describe the species under the name of *Goniaster* (*Goniodiscus*) *Hunteri*, and his type-specimen, which is figured in Dixon's 'Geology and Fossils of the Tertiary and Cretaceous Formations of Sussex,' pl. xxi, fig. 1, formed part of John Hunter's Collection, now preserved in the Museum of the Royal College of Surgeons. The examples illustrated in the present work are all preserved in the British Museum.

Variation.—There are at least two well-preserved examples in the collection of the British Museum which I consider to be varieties of this species. They are characterised by the presence of only four supero-marginal plates on each side of the disk, exclusive of the odd terminal plates, as against six plates in typical examples. Beyond this difference in number and the relatively greater length of the supero-marginal plates in proportion to their breadth, I can indicate no character worthy of being noted which would distinguish the examples in question from the typical form of *Mitraster Hunteri*. The specimens under notice measure 35 mm. and 30 mm. in diameter (R + *r*) respectively. Both are from the Upper Chalk, one from near Bromley, the other being only labelled "Kent." Figures of the first-mentioned are given on Pl. IX, figs. 3 *a*—3 *e*.

2. Mitraster rugatus, *Forbes*, sp. Pl. XVI, figs. 3 *a*—5 *d*.

Goniaster (Goniodiscus) rugatus,			*Forbes*, 1848. Memoirs of the Geological Survey of Great Britain, vol. ii, p. 471.
—	—	—	*Forbes*, 1850. In Dixon's Geology and Fossils of the Tertiary and Cretaceous Formations of Sussex, London, 4to, p. 330, pl. xxi, figs. 2, 2*; pl. xxiii, fig. 15.
—	—	—	*Morris*, 1854. Catalogue of British Fossils, 2nd ed., p. 81.
Astrogonium rugatum,			*Dujardin and Hupé*, 1862. Hist. Nat. Zooph. Échin. (Suites à Buffon), p. 399.
Goniaster (Goniodiscus) rugatus,			*Forbes*, 1878. In Dixon's Geology of Sussex (new edition, Jones), p. 364, pl. xxiv, figs. 2, 2*; pl. xxvi, fig. 15.

Body of small size. General form depressed. Abactinal surface flat. Actinal surface also flat. Marginal contour pentagonal with almost straight sides. The major radius is proportional to the minor radius as 100 : 75. The actual measurements in an example from the Upper Chalk of Gravesend, preserved in the British Museum, being, major radius, 17·5 mm.; minor radius, 13·75 mm. The rays are not produced beyond the contour of a true pentagon, and the radial angles are not rounded. Margin moderately thick, the lateral wall being almost vertical in consequence of the rapid bend from the abactinal and actinal surfaces; the bend to the actinal surface is, however, rather more gradual.

The supero-marginal plates are three in number, counting from the median interradial line to the extremity, or six from the tip of one ray to the tip of the adjacent ray, exclusive of the odd terminal or "ocular" plate in each case. They form a broad border to the abactinal area of the disk, of uniform breadth throughout, which measures 6 mm. at the median interradial line in an example whose diameter (R + *r*) measures about 31 mm. Excepting the ultimate plates, the supero-marginal plates are approximately equal in size, the breadth being nearly twice the length, the actual measurements in the above-mentioned specimen of 31 mm. in diameter being, length 3·5 to 3·6 mm., and breadth 6 mm. in the plate adjacent to the median interradial line. The corresponding plate in another example has a breadth of 5 mm. and length 2·75 mm., and in a third, breadth 5·5 mm. and length 2·75 to 2·8 mm. In the plate adjacent to the median inter-

radial line the length at the outer and at the adcentral margin is equal, but in the second plate the length at the adcentral margin is greater than at the outer margin in consequence of a slight extension of the plate to make up for the diminution in size of the ultimate plate, the distal lateral margin of the second plate appearing to be slightly hollowed out for the reception of the ultimate plate, and the corresponding second plates of two adjacent rays consequently touch at their adcentral ends. The ultimate plate is triangular or wedge-shaped in form, and its breadth is less than that of the other supero-marginal plates, and the corresponding plates of the two adjacent sides touch one another thoughout, the line of junction falling in the median line of the ray. The ultimate plate is not unfrequently a little longer at the outer margin than the other supero-marginal plates.

The abactinal surface of the plates is regularly convex along the line of breadth, almost resembling the segment of a cylinder, and no special gibbosity is developed. The abactinal area and the lateral area of the plate form a right angle, and the uniting curve is short and abrupt. The height of the supero-marginal plates, as seen in the margin, is less than their length, the height being 2·25 mm. where the length is 2·75 mm. There is no diminution in height as the plates approach the extremity of the ray, and no special prominence is noticeable in the ultimate plate. The abactinal surface of the plates is ornamented with irregular and frequently elongate eminences or ridges, which are usually disposed transversely or in the direction of the length of the plate. Two or three series may be present, as in Pl. XVI, fig. 4, or the linear ridges may be bent at a right angle, or otherwise curved—a character which is probably the result of several eminences being merged together, by which means a peculiar hieroglyphic-like marking is produced, which fancifully resembles Chinese writing to a certain extent (see Pl. XVI, fig. 5 *c*). This character is emphasised in weathered specimens. The ornamentation covers the whole abactinal area of the plate, but does not extend upon the lateral wall. Sometimes the form of the eminences is more rounded and tuberculiform, as in *Mitraster Hunteri;* this is distinctly the case in one example, and minute punctations are present in the channels which intervene, but it is to be noted that the tubercles and pits cover the *whole* abactinal area of the plate, and that there is no gibbosity, with its outer flank devoid of tubercles, as in *Mitraster Hunteri.* There is a very narrow depressed border round the entire margin of the plate, from which the regular convexity of the plate rapidly rises. The border is very minutely punctate, and there appears to be usually only a single regular lineal series of punctations. The ornamentation of the ultimate paired plates is similar to that on the other supero-marginal plates, but is more rounded and tubercle-like even in an example in which the broad lineal ornamentation occurs on the other plates.

The odd terminal or so-called "ocular" plate must be very small in order to fit the space left by two adjacent ultimate supero-marginal plates; but I am unable to describe the plate, as I have only found a trace of it in one instance, and have not seen a perfect one preserved in any of the examples of the species I have examined.

The abactinal area of the disk within the boundary of the marginal plates is paved with large polygonal plates, whose surface is marked with a very minute, closely crowded uniform granulation, upon which small miliary granules were previously borne. Traces of these granules are still occasionally present in some examples. The abactinal plates in this species are all large in relation to the size of the disk, and the primary apical plates are much larger than any of the others. The primary apical plates and several of the other plates have a central, small, low, irregular eminence, such as might be formed by the merging together and partial grinding down of a number of granules. I am unable to explain this structure, or to consider it as associated with a pedicellarian apparatus, of which I see no trace. It may possibly mark the remains of a tubercle which had existed in an early stage of the animal's life, but had disappeared and been outgrown at a later stage.

The madreporiform body, which is very small, is circularly subtriangular in shape, and is marked with fine regularly radiating striations. In the example under notice two large plates surround two-thirds of the circumference of the madreporite. In this specimen the madreporiform body measures 1·5 mm. in diameter, and the largest primary plate is 3·2 mm. in diameter.

The infero-marginal plates are five in number, counting from the median interradial line to the extremity,—that is to say, there are ten for the whole side of the disk as against six in the supero-marginal series. The length of the two innermost plates on each side of the median interradial line is greater than that of the corresponding supero-marginal plates, consequently the second infero-marginal plate extends a little way beneath the ultimate supero-marginal plate, and the remaining three infero-marginal plates are all under the ultimate supero-marginal plate. In some examples I am inclined to think that probably only four infero-marginal plates were present, counting from the median interradial line to the extremity, in which case the edge of the second and the remaining two plates were under the ultimate supero-marginal plate.

I have unfortunately not seen any example of this species in which the actinal surface of the disk is exposed, I am therefore unable to give the dimensions of the infero-marginal plates on the actinal surface, or to describe their ornamentation. For the same reason I am prevented from offering any remarks on the adambulacral and actinal intermediate plates.

Dimensions.—The example figured on Pl. XVI, fig. 3 *a*, has a major radius of about 17·5 mm., and the minor radius is about 13·75 mm. The length of the side is about 20 mm. The fragmentary type-specimen figured by Forbes, which is drawn on Pl. XVI, fig. 5 *a*, was probably about the same size, judged by computation of the half-side.

Locality and Stratigraphical Position.—One of the type specimens figured by Forbes is stated to have been obtained from the Upper Chalk of Wiltshire, but the second specimen, which is now preserved in the British Museum, bears no record of any locality. Forbes also records the species from Kent and Sussex. Authentic examples from the Upper Chalk from Gravesend and "Kent" are preserved in the British Museum.

History.—This species was described by Forbes in his memoir "On the Asteriadæ found fossil in British Strata" ('Mem. Geol. Surv.,' vol. ii, p. 471, 1848), and figures of two examples were given in Dixon's 'Geology and Fossils of the Tertiary and Cretaceous Formations of Sussex,' London, 1850, pl. xxi, figs. 2, 2*; pl. xxiii, fig. 15. The latter specimen is now preserved in the British Museum (register-number "E 2585"), and is illustrated on Pl. XVI, fig. 5 *a*, of the present work. I have not been able to find any trace of the other example figured by Forbes, which originally formed part of the collection belonging to the late Mr. Channing Pearce. Forbes states that it was found in Wiltshire.

Remarks.—Although at first sight the differences between *Mitraster Hunteri* and *Mitraster rugatus* appear well marked, I am not perfectly satisfied as to the species being altogether independent. When the types alone are examined there appears to be no need for any doubt upon this question. But examples occur which are exceedingly difficult to determine on account of presenting features which seem to break down some character which has been regarded as diagnostic of the other species. In illustration of this difficulty I have drawn on Pl. XVI, fig. 3 *a*, an example which I have ranked under *Mitraster rugatus*, but which presents considerable superficial resemblance to *Mitraster Hunteri* in the character of the ornamentation of the supero-marginal plates. I believe, however, that the proportions of the plates, the absence of any abactinal gibbosity, and the extension of the tuberculation over the whole abactinal area constitute, *inter alia*, a justification for regarding the example as *Mitraster rugatus*.

Turning, on the other hand, to a series of *Mitraster Hunteri*, considerable variation is to be noted in the relative length and breadth of the supero-marginal plates, as well as in the amount of gibbosity developed on the abactinal area of the plate. In such an example as that figured on Pl. XV, fig. 3 *a*, the proportions

PLATE IX.

PYCNASTER ANGUSTATUS, *Forbes*, sp. (Page 21.)

From the Upper Chalk.

FIG.

1 *a*. Abactinal aspect; natural size. (Coll. Brit. Mus.)
b. Lateral view of the margin; natural size.

METOPASTER PARKINSONI, *Forbes*, sp. (Page 31.)

From the Upper Chalk.

2 *a*. Actinal aspect; natural size. (Coll. Brit. Mus.)
b. Lateral view of the margin; natural size.
c. An infero-marginal plate; magnified.

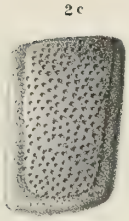
MITRASTER HUNTERI, *Forbes*, sp. (Page 59.)

From the Upper Chalk.

3 *a*. Abactinal aspect of a small example with four supero-marginal plates; natural size. (Coll. Brit. Mus.)
b. Actinal aspect of the same; natural size.
c. Lateral view of the margin; natural size.
d. A supero-marginal plate; magnified.
e. An infero-marginal plate; magnified.

2a.

3d.


2c

2b

3a

3b.

1a

3c.

3e

1b.

PLATE X.

METOPASTER PARKINSONI, *Forbes*, sp. (Page 31.)

From the Upper Chalk.

FIG.

1. Abactinal aspect; natural size. (Coll. Brit. Mus.)

2 *a*. Abactinal aspect of another example; natural size. (Coll. Brit. Mus.)

b. A supero-marginal plate; magnified 3 diameters.

c. The madreporiform body; magnified.

d. An abactinal intermediate plate, with pedicellarian apparatus; magnified.

3 *a*. Actinal aspect of another example; natural size. (Coll. Brit. Mus.)

b. Lateral view of the margin; natural size.

c. Adambulacral plates; magnified.

4 *a*. Actinal aspect of another example; natural size. (Coll. Brit. Mus.)

b. An infero-marginal plate; magnified.

c. An actinal intermediate plate; magnified.

5 *a*. Abactinal aspect of a young (?) example; natural size.

b. A supero-marginal plate of the same; magnified 4 diameters.

c. Abactinal intermediate plates; magnified.

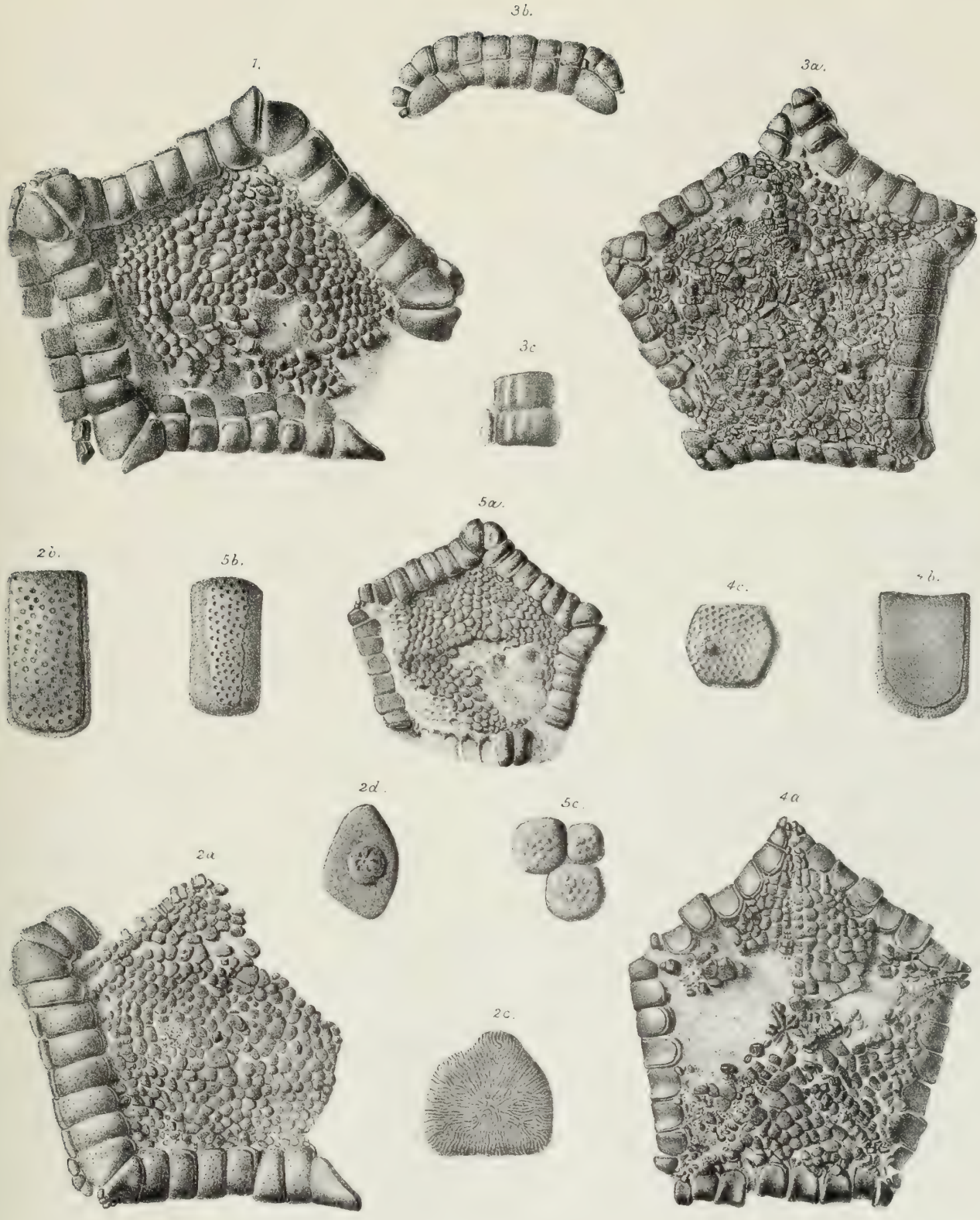

3b.
1.
3a.
3c
5a.
2b.
5b.
4c.
4b.
2d.
5c.
4a
2a
2c.

PLATE XI.

METOPASTER PARKINSONI, *Forbes*, sp. (Page 31.)

From the Upper Chalk.

FIG.

1 *a*. Abactinal aspect; natural size. (Coll. Brit. Mus.)
b. A supero-marginal plate; magnified 3 diameters.
c. The madreporiform body; magnified 6 diameters.
2 *a*. Abactinal aspect of another example; natural size. (Coll. Brit. Mus.)
b. A supero-marginal plate; magnified.
c. An abactinal intermediate plate; magnified.

METOPASTER UNCATUS, *Forbes*, sp. (Page 47.)

From the Upper Chalk.

3 *a*. Actinal aspect of a specimen from which the whole actinal floor has been removed, showing the inner surface of the abactinal floor; natural size. (Coll. Brit. Mus.)
b. Abactinal intermediate plates, inner surface; magnified.

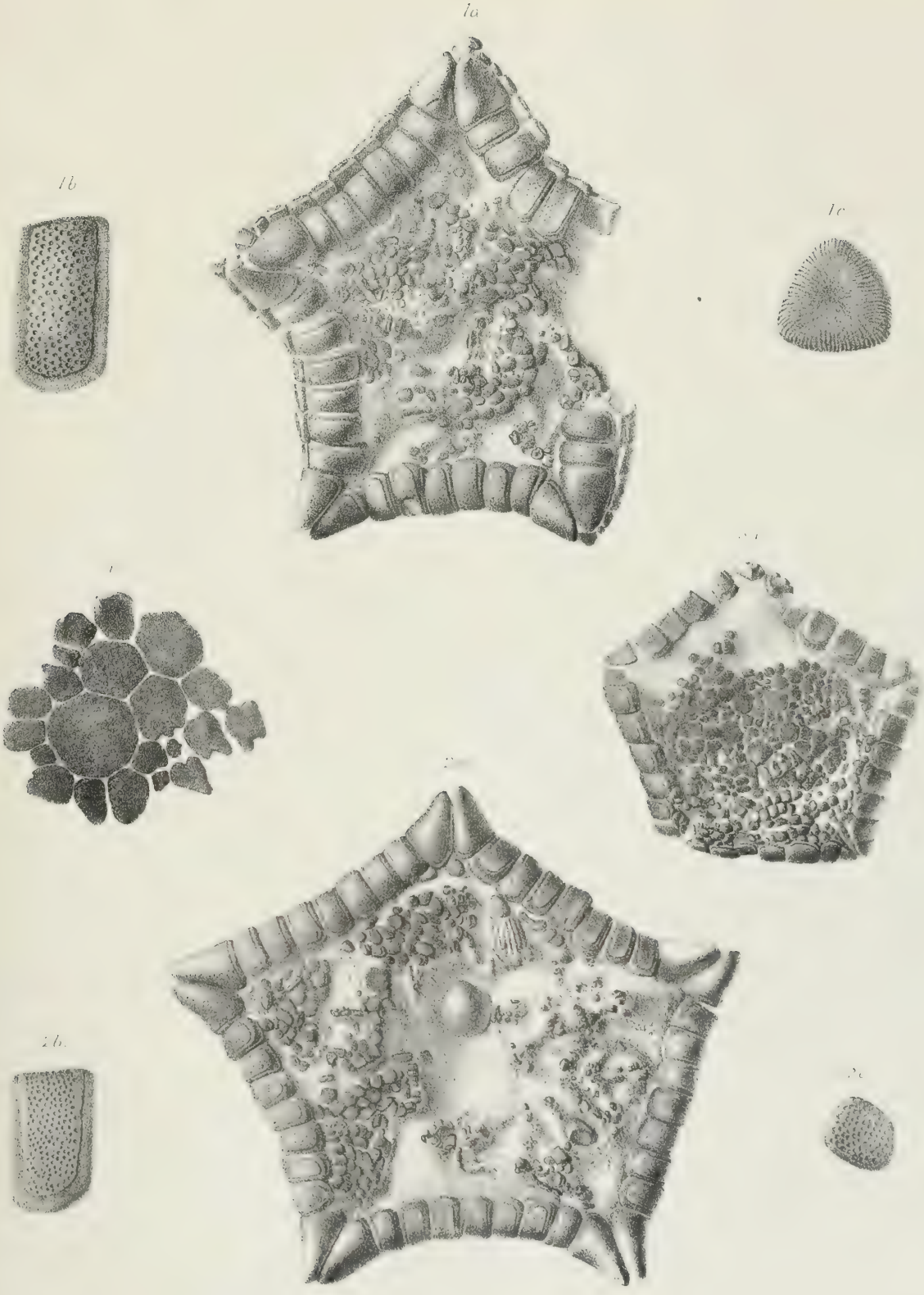

1a
1b
1c
2
2b
2c

PLATE XII.

METOPASTER PARKINSONI, *Forbes*, sp. (Page 31.)

From the Upper Chalk.

FIG.

1 *a*. Abactinal aspect; natural size. (Coll. Brit. Mus.)
b. Lateral view of the margin; natural size.
c. A supero-marginal plate; magnified.
d. The madreporiform body; magnified.
e. Abactinal intermediate plates; magnified.

METOPASTER ZONATUS, *Sladen*. (Page 45.)

From the Upper Chalk.

2 *a*. Abactinal aspect; natural size. (Coll. Brit. Mus.)
b. Lateral view of the margin; natural size.
c. The madreporiform body; magnified.

MITRASTER HUNTERI, *Forbes*, sp. (Page 59.)

From the Upper Chalk.

3 *a*. Actinal aspect; natural size. (Coll. Brit. Mus.)
b. Lateral view of the margin; natural size.
c. A supero-marginal plate; magnified.
d. An infero-marginal plate; magnified.
e. Actinal intermediate plates; magnified.

CALLIDERMA MOSAICUM, *Forbes*, sp. (Page 9.)

From the Lower Chalk.

4 *a*. Actinal aspect; natural size. (Coll. Brit. Mus.)
b. Lateral view of the margin; natural size.
c. Mouth-plates; magnified.
d. An infero-marginal plate; magnified.

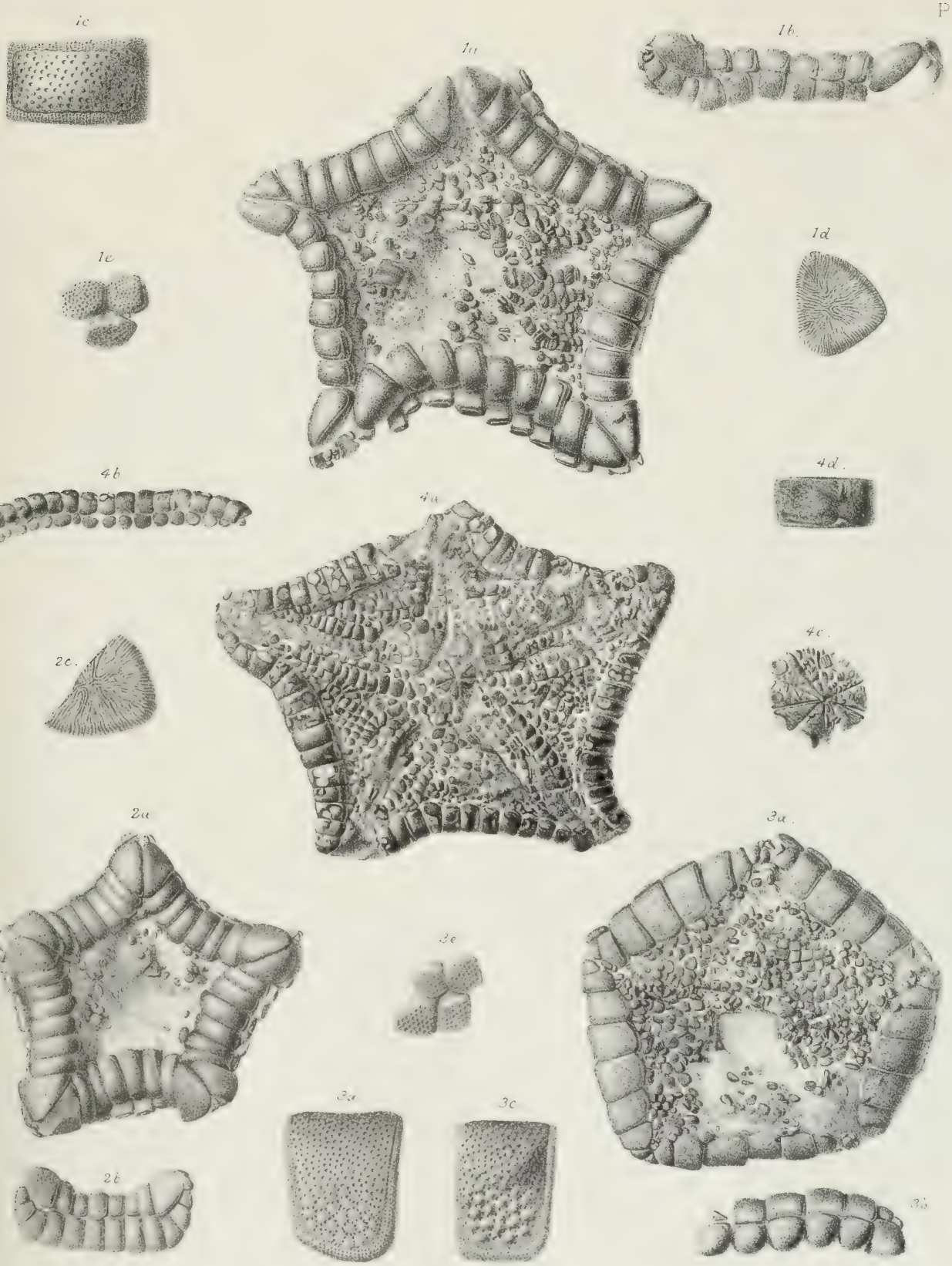

1c
1b.
1a
1d
1e
4b
4d.
4a
2c.
4c.
2a
3a.
3e
3a
3c
2b
3b

PLATE XIII.

PENTAGONASTER MEGALOPLAX, *Sladen*. (Page 27.)

From the Upper Chalk.

FIG.

1 *a*. Abactinal aspect; natural size. (Coll. Brit. Mus.)
b. A supero-marginal plate; magnified 3 diameters.

METOPASTER MANTELLI, *Forbes*, sp. (Page 38.)

From the Upper Chalk.

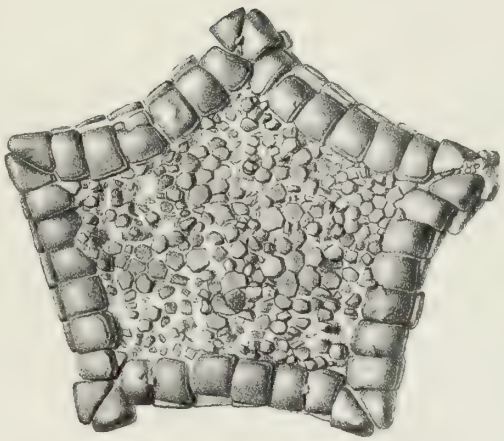
2 *a*. Abactinal aspect; natural size. (Coll. Brit. Mus.)
b. A supero-marginal plate (much weathered); magnified 3 diameters.
c. The madreporiform body and surrounding plates; magnified.
d. Abactinal intermediate plates; magnified 6 diameters.
3 *a*. Abactinal aspect of the example figured by Forbes; natural size. (Coll. Brit. Mus.)
b. A supero-marginal plate; magnified 3 diameters.
4 *a*. Actinal aspect of another example figured by Forbes; natural size. (Coll. Brit. Mus.)
b. An infero-marginal plate; magnified 3 diameters.

1a.

2c.

1b.

2a.



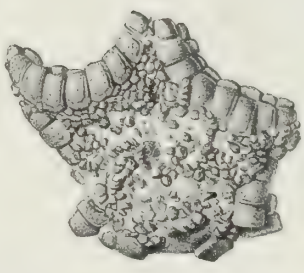
3b.

2b.

2d.

3a.

4a.



4b.

PLATE XIV.

METOPASTER UNCATUS, *Forbes*, sp. (Page 47.)

From the Upper Chalk.

FIG.

1 *a*. Abactinal aspect; natural size. (Coll. Brit. Mus.).
b. An ultimate paired supero-marginal plate; magnified.
2 *a*. Abactinal aspect of another example; natural size. (Coll. Brit. Mus.)
b. Lateral view of the margin; natural size.
c. A supero-marginal plate; magnified.
d. The madreporiform body; magnified 4 diameters.
3. Actinal aspect; copied from the figure given by Forbes in Dixon's 'Geology of Sussex' (pl. xxi, fig. 5).

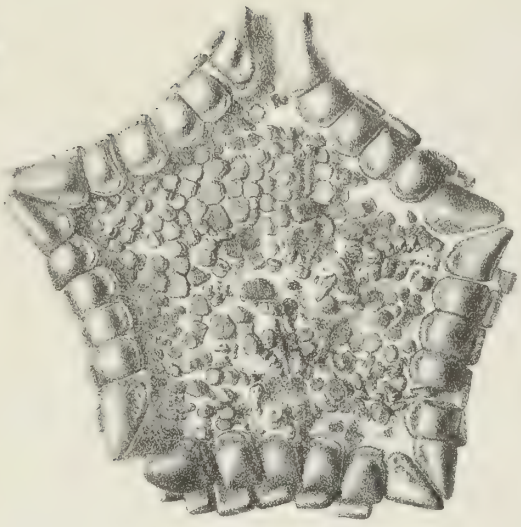
METOPASTER CINGULATUS, *Sladen*. (Page 53.)

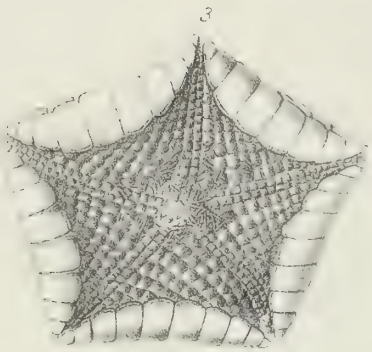
From the Upper Chalk.

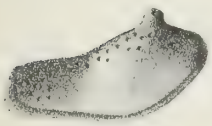
4 *a*. Abactinal aspect; natural size. (Coll. Brit. Mus.)
b. Lateral view of the margin; natural size.
c. A supero-marginal plate; magnified.
d. An abactinal intermediate plate; magnified.

METOPASTER CORNUTUS, *Sladen*. (Page 55.)

5 *a*. Abactinal aspect; natural size.
b. Lateral view of the margin; natural size.
c. An ultimate paired supero-marginal plate seen from above; magnified.
d. The same seen in profile (lateral view); magnified.







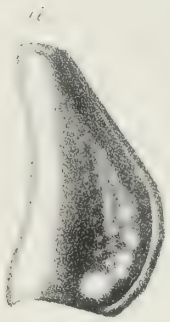


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PLATE XV.

METOPASTER UNCATUS, *Forbes*, sp. (Page 47.)

FIG.

1 *a*. Actinal aspect; natural size. (Coll. Wright.)
b. Lateral view of the margin; natural size.

METOPASTER BOWERBANKII, *Forbes*, sp. (Page 42.)

From the Upper Chalk.

2 *a*. Actinal aspect; natural size. (Coll. Geol. Survey.)
b. Lateral view of the margin; natural size.
c. An infero-marginal plate (weathered); magnified.
d. Mouth-plates; magnified.

MITRASTER HUNTERI, *Forbes*, sp. (Page 59.)

From the Upper Chalk.

3 *a*. Abactinal aspect; natural size. (Coll. Brit. Mus.)
b. A supero-marginal plate; magnified 3 diameters.
4 *a*. Actinal aspect of another example; natural size. (Coll. Brit. Mus.)
b. An infero-marginal plate; magnified 3 diameters.
c. Extremity of the radial region; magnified 3 diameters.
d. Abactinal intermediate plates, seen from within; magnified 6 diameters.
5 *a*. Actinal aspect of another example; natural size. (Coll. Brit. Mus.)
b. An infero-marginal plate; magnified 3 diameters.

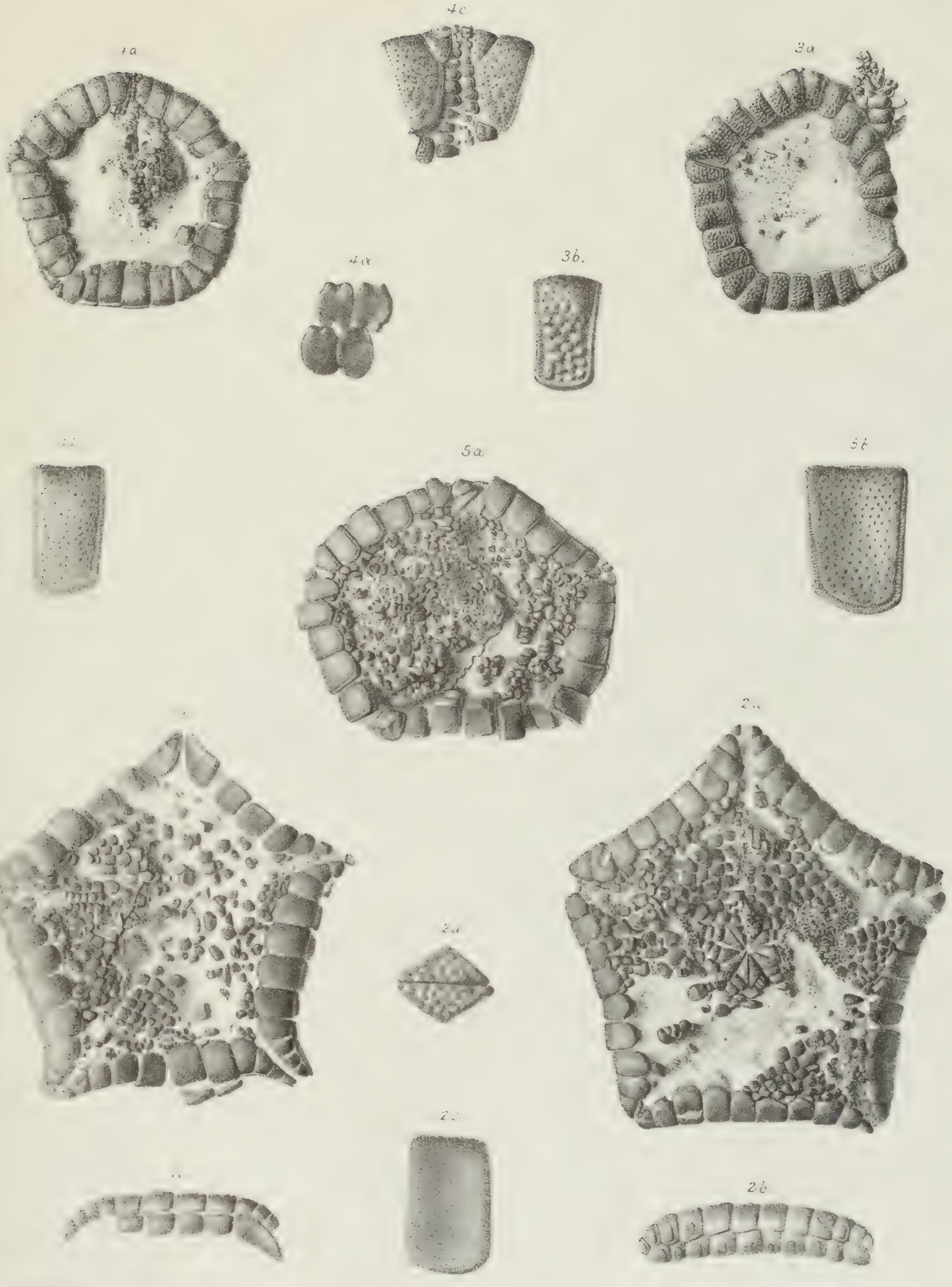

4c
4a
3a
4d
3b
5a
5b
2a
2d
2c
2b

PLATE XVI.

Metopaster Bowerbankii, *Forbes*, sp. (Page 42.)

From the Upper (?) Chalk.

Fig.

1 *a*. Abactinal aspect of the example figured by Forbes, natural size. (Coll. Brit. Mus.)

b. Lateral view of the margin; natural size.

c. The last three supero-marginal plates; magnified 2 diameters.

d. Abactinal intermediate plates; magnified 6 diameters.

Metopaster Parkinsoni, *Forbes*, sp. (Page 31.)

From the Upper Chalk.

2 *a*. A pair of ultimate supero-marginal plates and the odd terminal or "ocular" plate; magnified 2 diameters. (Coll. Brit. Mus.)

b. Lateral or marginal view of the same; magnified 2 diameters.

Mitraster rugatus, *Forbes*, sp. (Page 63.)

From the Upper Chalk.

3 *a*. Abactinal aspect; natural size. (Coll. Brit. Mus.)

b. A supero-marginal plate; magnified 3 diameters.

4. Supero-marginal plates of another example; magnified 2 diameters. (Coll. Brit. Mus.)

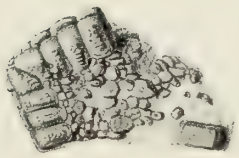
5 *a*. Abactinal aspect of the example figured by Forbes; natural size. (Coll. Brit. Mus.)

b. Lateral view of the margin; natural size.

c. A supero-marginal plate; magnified 3 diameters.

d. Profile or sectional view of the margin, showing a supero-marginal and an infero-marginal plate; magnified 3 diameters.

5a



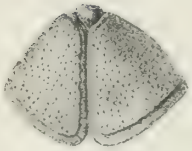
4.

5b

5c.

3a

2a.



5d

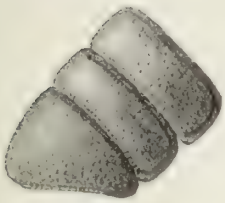
2b

3b

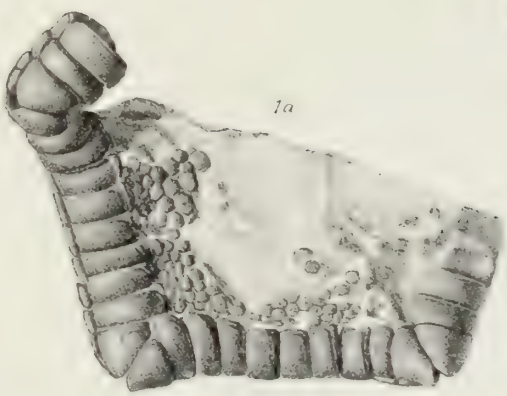
1b.

1a'

1c



1a



THE

PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCXLVII.

VOLUME FOR 1893.

LONDON:

MDCCCXCIII.

A MONOGRAPH

ON THE

INFERIOR OOLITE AMMONITES

OF

THE BRITISH ISLANDS.

BY

S. S. BUCKMAN, F.G.S.,

HONORARY MEMBER OF THE YORKSHIRE PHILOSOPHICAL SOCIETY.

PART VIII.

PAGES 345—376; PLATES LXXVII—XCII.

LONDON:

PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.

1893.

PRINTED BY ADLARD AND SON,
BARTHOLOMEW CLOSE, E.C., AND 20, HANOVER SQUARE, W.

Ventral inclination of ribs (or growth-lines) more marked :

S. biplicata β. More spinous, less costate, and more involute than *biplicata* α.

S. alternata β. Very similar to *alternata* α, but the ventral inclination of the ribs (or growth-lines) much more marked.[1]

The genetic affinities of the *biplicata*-stock are very easily determined. The very strongly-reclining ribbing brings it into relationship with the *acanthodes*-stock ; and the gibbous-sided whorl is a confirmatory feature. The irregular and regular spinous stages point in much the same direction as the same features of *acanthodes*, &c., to a spinous form like *crassispinata*. The differences in the costate stages prevent derivation from *acanthodes;* but the similarity of the spinous stages points to a common origin for *biplicata* and *acanthodes*.

From external characters it would appear that *biplicata* α developed into *alternata* α, and *biplicata* β into *alternata* β; but it has been found that the duplication of the outer lobule of the superior lateral lobe in *biplicata* α is much too pronounced to allow this view to be held. Possibly, before the descriptions of *Sonniniæ* are finished, the advent of more material will enable me to treat more critically the forms now grouped in " the *biplicata*-stock."

SONNINIA BIPLICATA, *S. Buckman*. Plate LXXVIII.

Discoidal, compressed, hollow-carinate. Whorls, in section, circular to elliptical, ornamented, after the usual regular and irregular spinous stages, with strongly-marked, reclining ribs, arranged first in pairs—the more-marked and the less-marked,—later, an obscure and well-marked rib in alternation: the pairs of strongly-marked ribs approximate, and with a tendency to be connate on the inner area.[2] Ventral area obtusely arched, slightly flattened in the middle, which is divided by a fairly-marked hollow carina; the ribs on the sides of the ventral area rather obscure, ventrally-inclined. Inner margin nearly upright, subconvex ; but it is scarcely defined, as the upper edge is so much rounded off. Inclusion about one-third. Suture-line rather ornate, the superior lateral lobe tetradactyloid on account of bipartition of the outer lobule.

[1] Viewed from behind, the ribs (or growth-lines) of *alternata* α join the carina at an angle of about 50°, those of β at 25°.

[2] The pairs of strongly-marked ribs are doubtless homologous to spines—in fact, they may be regarded as aborted spines. Often, in the irregular spinous stage of the *Sonniniæ*, a single rib leads up to the spine and bi- or trifurcates beyond. In the present case it may be said that the spine is transformed into a kind of duplicated primary rib.

This description applies to the type only; but I have separated two forms under the name *biplicata*, thus:

α. The type (Pl. LXXVIII, figs. 1—3).

β. The spinous stage rather longer, the succeeding costæ not so marked, the ribs rather more turned on the ventral area (Pl. LXXVIII, figs. 4, 5).

The peculiar arrangement of the ribbing in the costate stage effectually separates this species from any other I have described. At first the ribs are of two sizes, the larger being very strongly marked. The more-marked ribs are arranged somewhat in pairs, roughly alternating with pairs of the less-marked ribs; and, so far as regards the strongly-marked ribs, the space which connects the ribs forming the pair is often elevated, so that the pair at the inner end look somewhat like a broad single rib medianly-sulcate. Later on, the ribs are single, and an obscure rib alternates with one well-marked.

The ornamentation above described is not so noticeable in *biplicata* *β*, because it has barely finished with the spinous stage; but somewhat the same "alternation" may be detected. The *Concavum*-zone of Bradford Abbas has yielded the examples of this rare form which are in my cabinet. The form *α* is illustrated in Pl. LXXVIII, figs. 1—3, and the form *β* in figs. 4, 5 of the same plate.

Sonninia alternata, *S. Buckman.* Plate LXXVI, figs. 7—9; Plate LXXVII, figs. 3—5.

1881. Harpoceras adicrum, *S. Buckman* (non *Waagen*). Inf. Oolite Ammonites; Quart. Journ. Geol. Soc., vol. xxxvii, p. 603 (pars).

Discoidal, compressed, hollow-carinate. Whorls, in section, elliptical, ornamented in the costate stage with irregular-sized, reclining ribs, at first somewhat in pairs, later on alternate.[1] Ventral area subobtusely arched, divided by a fairly-prominent hollow carina. Inner margin well-defined, nearly upright. Inclusion rather less than one-half.

As *alternata* I have separated two forms; but, practically, the only difference between them is that in the form *β* (Pl. LXXVI, figs. 7—9) the ribs (or growth-lines) are more ventrally-inclined—they might almost be called ventrally-projected—than in the form *α* (Pl. LXXVII, figs. 3—5), in which they are only inclined.

In *Sonn. alternata* the spinous stage ends rather earlier than in *biplicata*. In the

[1] See description of preceding species.

costate stage the whorls are flatter-sided, altogether thinner, and less ornamented. The ribs, which are not so strongly marked, do not show the "biplication" so conspicuously in *alternata* α as in *biplicata;* but in *alternata* β, in which it is not hidden by the overlapping whorl, the biplication is very noticeable. The alternation of a well-marked and an obscure rib is a noticeable feature on the last part of the whorl of *alternata.* In addition to the points noted above, the more compressed, more involute shape, and the more marked inner margin separate *alternata* from *biplicata.*

The specimen depicted as *alternata* α was one of the forms which I regarded as *Harp. adicrum* in a paper on Inferior Oolite Ammonites (see *syn.*). Although it agrees to a certain extent with Waagen's fossil, so far as the spinous stage is concerned, yet in the costate stage its costæ are far more numerous: its whorls are also thicker.

Sonn. alternata is a rare fossil from the *Concavum*-zone of Bradford Abbas. The example shown in Pl. LXXVII, figs. 3—5, possesses the test, but its inner whorls have suffered somewhat in cleaning. The young shell depicted in Pl. LXXVI, figs. 7—9, shows irregularity of costæ and biplication very effectively. It is an excellently-preserved specimen.

The *crassa*-stock.

This stock contains some of the most characteristic *Sonniniæ* of the *Concavum*-zone. Some of the spinous species I had at one time confounded[1] with *Am. adicrus*, Waagen; but this was an error committed when I possessed only a few specimens of the genus compared with my present series. I need scarcely point out the many differences between these forms and *adicrus*—differences of whorl-shape, spinosity, costation, and suture-line, none of which can be disregarded.

The forms of the *crassa*-stock are characterised by possessing nearly upright ribs even during the spinous stage, a feature which brings them into connection with the *dominans*-stock; but the species of the *crassa*-stock may be distinguished therefrom by *being thicker and more spinous in proportion to the size of the umbilicus.* There is one exception to this which I shall notice in its place (p. 356).

The members of the *crassa*-stock may be further subdivided into two series, namely, species in which the costate stage is fairly developed, and species in which the costate stage is very short. In the latter series the shortness of the costate stage brings the smooth stage into close connection with a well-marked

[1] 'Quart. Journ. Geol. Soc.,' vol. xxxvii, 1881.

spinous stage, so that there is a great contrast between the ornamentation of the inner and outer whorls.

The various species of the *crassa*-stock may be separated from one another thus:

S. crassiformis, spinous to bullicostate.[1]

S. crassa, centrally spinous, but mostly costate. A very thick form, especially considering the comparatively small umbilicus.[2]

S. crassinuda, centrally spinous, adult smooth.

S. nuda, almost completely smooth.

These species illustrate various phases of retrogression. Parallel herewith runs the other series, in which the later spinous stage has its spines at first rather distant, but as the series develops they close up—the effect presumably of accelerated development,—so that the infantile stage of the later forms has a remarkable likeness to adolescent *crassiformis*. In point of development the first species may be placed between *crassiformis* and *crassa*. These species are—

S. crassibullata, spinous, bullicostate to costate.

S. crassicostata, the same, but losing the ribs very early.

S. diversa, with numerous spines, then subcostate.

S. lævigata, like one form of *crassinuda*, but with a very deficient spinous stage. For the most part nearly smooth.

The genealogical position of the *crassa*-series cannot be exactly determined—on this point see the following article on *crassiformis;* but, so far as its general appearance is concerned, *crassiformis* takes a place between *acanthodes* and *irregularis*.

Sonninia crassiformis, *S. Buckman*. Plate LXXIX, figs. 1—6.

Discoidal, compressed, hollow-carinate. Whorls, in section, elliptical, ornamented first with strong, regularly-placed spines set on slightly reclining obscure ribs, which part into two or three beyond the spines; later with large single, direct, almost upright,[3] ventrally-inclined costæ, which are elevated in the middle to blunt elongate knobs (bullicostate). Ventral area arched, divided by a strong, rather thick hollow carina. Inner margin only in adult; then subconvex, upper part rounded off. Inclusion in youth up to the spines; in adult

[1] See page 353, footnote 1.

[2] The general law of retrogression is that the whorls become more compressed as the umbilicus becomes smaller, so that *in proportion* to the size of its umbilicus this species is very thick-whorled.

[3] The costæ become more upright with age, and are quite upright at the end of whorl.

not quite so far. Termination, adult, a plain edge, parallel to ribs and growth-lines. Suture-line with a tetradactyloid superior lateral lobe, the outer lobule being in duplicate.

This species is one of the giants of the *Concavum*-zone, and is the largest of the spinous *Sonniniæ*. The splendid adult example (figs. 3, 4), which is complete, measures 290 mm. ($11\frac{3}{8}$ inches) in diameter.

Biologically this species is the morphological equivalent of *acanthodes* and *irregularis*. From the former it may be distinguished by the whorls overlapping to the spines for a longer time, by greater regularity of ornament, and by the more upright ribs; and from the latter by greater regularity of ornament—the regularity of the spines being particularly noticeable,—by its large bullicostæ, and by its more inflated whorls. It will thus be evident that from the characters of their side-surface alone these three species are distinguishable thus:

S. acanthodes, ornamentation somewhat irregular, ribs very strongly reclined.

S. irregularis, ornamentation very irregular, ribs nearly upright.

S. crassiformis, ornamentation very regular, ribs nearly upright.

In regard to descent, there is no evidence, in the inner whorls, of that irregular spinous stage which is seen in *crassispinata*; but this possible stage in the phylogeny may have been omitted from the ontogeny by the tendency to dispense with dissimilar stages. On the other hand, it is as reasonable to suppose direct derivation from *multispinata*—an enlargement of spines with more inflated whorls; and this agrees with the ontogeny.

Sonn. crassiformis is a scarce species in the *Concavum*-zone of Bradford Abbas. An immature example of the species showing the regularity of the spines is depicted in figs. 1, 2, Pl. LXXIX; and in figs. 3, 4 of the same plate are copies of two photographs of the side-views of a giant adult, reduced, being 95 mm. against 290 mm. in diameter. The outline of the aperture, and the suture-line of this fossil are shown in figs. 5, 6, both of natural size.

SONNINIA, sp. Plate LXXIX, figs. 7, 8.

In the same plate with the figures of *Sonn. crassiformis* I have placed a small fossil on account of its resemblance to that species in whorl-shape; but it has spines too small and too close together to be the young thereof. In the arrangement of its spines it is rather like *multispinata*, but has a more arched ventral area and differently-shaped whorls. It is probably a young example of an unknown

adult; and ought, perhaps, to be regarded as the morphological representative of a still earlier adult ancestor connecting *multispinata* with *crassiformis*.

I have no other example in my cabinet. The *Concavum*-zone of Bradford Abbas is its horizon.

SONNINIA CRASSA, *S. Buckman*. Plate LXXXII, figs. 1, 2.

Discoidal, compressed, carinate. Whorls, in section, oblong, ornamented with rather close, not very prominent, direct, upright, undulate ribs,[1] inclined, but obscure ventrally (the spinous stage only in the inner whorls). Ventral area rounded, divided by a small, presumably hollow carina. Inner margin broad, well-marked, subconvex, nearly upright. Inclusion about one-third, apparently more in youth. Umbilicus rather deep, somewhat excentric.

The external characters suggest that this species is the descendant of *crassiformis*—separated by some distance. It is decidedly much further removed from it than is *crassibullata* (page 353), the less elaborate spinous stage shows that; yet it has in general appearance a greater likeness to what would be expected as the development of *crassiformis*. The connecting link I assume to have been stronger and more closely costate than *crassibullata;* for *crassa* shares with *crassiformis* greater regularity of ornamentation and a more developed costate stage than are found in *crassibullata*. Certainly the costæ of *crassiformis* are really bullate, but an indication of the same feature is seen continued in the costæ of this species:[2] they are certainly elevated in the middle.

So far as the costate stage is concerned, *Sonn. crassa* is the morphological equivalent of *Sonn. dominans*,[3] to which it bears considerable resemblance. Not only, however, is it a considerably thicker shell, but in youth the spines are more numerous, and they last to a much later date; in fact, so far as the spinous stage is concerned it is not nearly so retrogressive as *dominans*.

This species occurs in the *Concavum*-zone. It does not appear to be common, but perhaps it has been passed over on account of its resemblance to *dominans*.

[1] The ribs increase in size considerably on the last quarter-whorl, and are altogether more prominent. The core of the body-chamber shows some obscure, inclined, rib-like markings on the ventral area between the true ribs.

[2] There are distinct bullicostæ in *crassa* between the true spines and the true ribs, but they are rather obscured by the involution.

[3] A small difference should be noticed. The ribs of *dominans* are more nearly of one size across the whorl; the ribs of *crassa* are raised in the middle, but rather obscure both on the inner and outer lateral areas.

The side view of an adult specimen reduced to two-thirds of natural size is shown in Pl. LXXXII, fig. 1, and the outline of its whorl-section, of natural size, in fig. 2.

SONNINIA CRASSINUDA, *S. Buckman.* Plate LXXXI, figs. 1—4.

Discoidal, compressed, carinate. Whorls, in section, oblong, ornamented only with a few irregularly-placed obscure ribs and bulges (the spinous and costate stages confined to the inner whorls). Ventral area arched, divided by a small doubtfully-hollow carina. Inner margin well-marked, broad, upright, nearly flat. Inclusion about one-half in immature shells, rather less in older specimens. Umbilicus deep, slightly excentric, ornamented with spines and small costæ.

I have included three forms in this species:

α. Thick (Pl. LXXXI, figs. 1, 2).

β. The type-form. Thinner, more costate, but less umbilicate (Pl. LXXXI, figs. 3, 4).

γ. Like *β*, but smoother.

Possibly the association of *α* and *β* in the same species is incorrect. Except, however, that *α* is smoother than *β* in the last part of the whorl, it seems to exactly link *crassa* with *β*; while *γ* is obviously a descendant of *β*, exhibiting smoothness at an earlier age. Practically, therefore, it may be supposed that the forms of this species show three developmental stages from *crassa* retrograding towards a smooth form.

From *crassa*, *Sonn. crassinuda* may be distinguished by the reduction of ornament in regard to the spinous and costate stages, and by the practically smooth whorls of the adults. From most of its morphological equivalents it may be known by its upright ribs; but it is therefore like *dominans*. It is, however, decidedly more spinous, and spinous to a later date; the succeeding costate stage is more irregular and less developed, the ribs[1] being smaller and closer together; while smoothness is a feature of adolescence. There is thus much more contrast between the ornamentation of the inner and outer whorls than in *dominans*.

I have only figured young forms of this species. Adults (160—180 mm. in diameter) show whorls practically smooth except for some obscure distant bulgings. They also exhibit a tendency for the umbilicus to become excentric, and in correlation therewith a slight increase in the proportionate thickness of the whorl.

[1] In the type-form the ribs are very irregular, many of the smaller ribs only developed on the outer two-thirds, and not on the inner area. The ribbing is somewhat like that shown for fig. 5 (Pl. LXXXI); but the larger ribs are more distant, and are parted by three or four short-length smaller ribs.

This is not an uncommon fossil of the *Concavum*-zone; and it occurs at Bradford Abbas. The side view (portion) and the outline section of the whorl of the thick form are shown in figs. 1, 2 of Pl. LXXXI; the side view and outline section of the whorl of a more costate and thinner form are illustrated in figs. 3, 4. The specimens depicted are immature.

Sonninia nuda, *S. Buckman.* Plate LXXXII, figs. 3, 4.

Discoidal, compressed, carinate. Whorls, in section, oblong, ventrally-convergent, practically without ornament. Ventral area arched, divided by a small, presumably solid carina. Inner margin well-marked, broad, upright, flat, upper edge rounded off. Inclusion about one-third—more in the young. Umbilicus excentric, regularly graduated, shelving outwards, ornamented with very rudimentary and obscure costæ.

The connection of this species with *crassinuda* α is effected through a specimen exactly intermediate in every respect. That specimen shows in its inner whorls a rudimentary spinous stage followed by a distinct costate stage; but the greater part of the fossil is smooth. In *nuda* there appears to be the least trace of a spinous stage followed by a very rudimentary costate stage, and then smoothness.

In mode of coiling the intermediate form bears out its position exactly, for it is more umbilicate than *nuda*, with less tendency to excentricity; on the other hand, its umbilicus is more excentric than that of *crassinuda*. Further, in regard to thickening of the whorl it is also intermediate.

The similarity between *nuda* and *simplex* is obvious. Being able to follow out nearly every step in the development of the two genetic series, I claim that the correct interpretation of the likeness is that these forms are the terminal morphological equivalents of two homoplastic series.

The two forms have not attained to anything like identity,—a much more perfect convergence is theoretically possible. From *simplex* the present species may be known by possessing a carina for a longer time,[1] by a less excentric umbilicus, and by the outward shelving of its whorls—a feature which also gives a deeper edge to the inner margin and a subtriangular appearance to the "aperture."

[1] The carina is distinct at 185 mm. diameter,—beyond that the ventral area is damaged. The eventual disappearance of the carina is certain—by analogy with terminals of other series.

The coiling of the umbilicus may be compared with *simplex* and *substriata* as under:

	nuda.	*simplex.*	*substriata.*
Diameter . . .	190 mm.	190 mm.	190 mm.
Umbilicus . . .	58 „	63 „	68 „
Umbilicus one whorl back .	23 „	22 „	27 „
Umbilicus two whorls back .	11 „	9 „	12·5 „

This rare and interesting species occurs in the *Concavum*-zone of Bradford Abbas. The side view and the outline section of its whorl are shown in figs. 3, 4 of Pl. LXXXII.

Sonninia crassibullata, *S. Buckman.* Plate LXXX, figs. 1—3.

Discoidal, compressed, carinate. Whorls rather flat-sided, in section somewhat oblong, ornamented with large, coarse spines passing into bullicostæ,[1] and then into direct, upright, subbullate, ventrally-obscure costæ. Ventral area obtusely arched, divided by a thick, not very elevated, presumably hollow carina. Inner margin distinct, broad, nearly upright, flat. Inclusion about three-eighths.

The bullicostæ characterise this species. These costæ are intermediate between spines and ordinary costæ. Where the whorl is not covered they are seen to be very different from the spines of the other species because of their elongate, obtuse shape.[2] When the outer part of the whorl is covered they appear much like spines; but they rise from the inner edge at a smaller angle, which is maintained until the inner margin of the overlapping whorl is reached. Spines, on the other hand, are elevated suddenly, and are carried up sharply alongside the inner margin as long cones.

The spinicostæ and bullicostæ are more distant than would be expected in the development of *crassiformis;* between nearly each one, also, there is a very small plain rib.[3] It is therefore hardly possible to derive this species direct from adult *crassiformis*, but it may be linked to the smaller specimen of that species—this smaller specimen being regarded as the morphological representative of an adult ancestor. Therefore the two series of the *crassa*-stock may be considered as

[1] Ribs, of which the middle is raised into an obtuse elongate knob. In the inner whorls these bullicostæ appear rather like spines, but their angle of elevation is less, and is uniform.

[2] Hence the name—*bulla* = a boss.

[3] In the examples which connect *crassibullata* and *crassicostata* an intermediate rib is often wanting.

parallel developments from an ancestor thus morphologically represented; and possibly the young specimen shown in Pl. LXXIX, figs. 7, 8, may, by morphologically representing the adolescent stage of that ancestor, and the adult stage of one still earlier, furnish a lower link in the series.

Next to *Sonn. obtusiformis* the present species is one of the most distinctly marked of any of the *Concavum*-zone *Sonniniæ*. Its upright ribs separate it from any morphological equivalents except *marginata;* from which it may be known not only because its costæ retrograde more quickly, so that there is a greater contrast between the strength of ornamentation of inner and outer whorls, but because the strength and arrangement of the ornamentation is unlike at all stages of growth.

Sonn. crassibullata is a somewhat rare fossil in the *Concavum*-zone; but it is always likely to attract attention because it can be so readily identified. All the specimens in my possession came from Bradford Abbas. The side view of a grand adult shell is shown in Pl. LXXX, fig. 1, the section of its whorl in fig. 2, and the suture-line from another specimen in fig. 3.

Sonninia crassicostata, *S. Buckman.* Plate LXXX, figs. 4, 5; and suture-line of an intermediate form, fig. 6.

Discoidal, compressed, carinate. Whorls, in section, oblong, ornamented with spines passing to bullicostæ, which yield at an early age to somewhat distant, ill-marked, direct, upright costæ. Ventral area arched, divided by a small, presumably hollow carina. Inner margin well-marked, fairly upright, flat. Inclusion about one-half.

The description of this species is somewhat like that of *crassibullata*—the difference lies in the age when the changes of ornament were assumed. In *crassibullata* subbullicostæ are present at 190 mm. diameter; in *crassicostata* these subbullicostæ yield to plain costæ at about 70 mm. diameter; and at about 100 mm. in diameter the costæ are becoming quite obsolete. The young *crassicostata* is the morphological representation of adult *crassibullata.*

This species is connected with *crassibullata* by a series of intermediate forms. It is thinner than that species, and is easily distinguished by the reduction of ornament. It cannot be confounded with any other *Sonninia;* it is far more spinous than *dominans*, or *crassinuda;* it is thinner, more regularly spinous, and then smoother than *crassa.*

It occurs in the *Concavum*-zone of Bradford Abbas, but is not common.

The side view of an immature shell is shown in Pl. LXXX, fig. 4, and the section of its whorl in fig. 5. The suture-line from a larger specimen, biologically somewhat nearer to *crassibullata*, is given in fig. 6.

SONNINIA DIVERSA, *S. Buckman.* Plate LXXXIII, figs. 1—4; an allied form, Plate LXXXI, figs. 5, 6.

Discoidal, compressed, hollow-carinate. Whorls, in section, circular to oblong, ornamented, first, with tall, slender, closely-packed, regular spines; afterwards by direct, nearly upright, somewhat irregularly-placed costæ, obscure on the outer area. Ventral area rounded, divided by a fairly-defined hollow carina. Inner margin well-defined, nearly upright, flat. Inclusion one-half. Umbilicus ornamented with numerous tall spines.

This species is biologically later than *Sonn. crassicostata*, and practically speaking it may be regarded as its descendant, though strictly it comes from a form intermediate between *crassibullata* and *crassicostata*. The regularity of its numerous, closely-packed spines in the inner whorls gives it a very distinctive appearance, besides separating it from *crassinuda*, in which the spines soon become irregular.

What appears to be a further development of this form is shown in figs. 5 and 6 of Pl. LXXXI. It will be noticed that it has the same well-marked regular spines, but they end at a much earlier age. It is like *crassinuda*, but does not show an irregular spinous stage. It is as widely umbilicate as *crassinuda* α, but much thinner; it is as thin as *crassinuda* β, but more umbilicate—it is also less spinous, and becomes smooth sooner. Therefore, compared with *crassinuda*, it is more umbilicate in proportion to thickness, or thinner in proportion to the size of its umbilicus. These facts seem to indicate its separation from *crassinuda*, and that in position it is the connecting link between *diversa* and *lævigata*. The regular spines of the central whorls, lasting longer than the regular spines in *crassinuda*, link it to *diversa* by the law of earlier inheritance; the smoothness of its outer whorl and its thin, umbilicate form link it to *lævigata* by the same law.

Sonn. diversa is distinguished from *crassicostata* by the greater number of smaller spines; from *dominans* and its allies by the absence of an irregular spinous stage, and by the sudden decline from well-marked spines to poorly-marked costæ; from *crassinuda* by the remarkable regularity of its spines.

This species is not common. My specimens are from the *Concavum*-zone of Bradford Abbas. Side and front views of an immature example are shown in figs. 1, 2 of Pl. LXXXIII; and the same views of quite a young form are given in figs. 3, 4. It should be noticed that this young form is like the *Sonninia*, sp., figured in Pl. LXXIX, figs. 7, 8; but the spines of its inner whorls are smaller and closer together, and its whorl is more compressed.

Sonninia lævigata, *S. Buckman.* Plate LXXXII, figs. 5, 6.

Discoidal, compressed, carinate. Whorls, in section, oblong, ornamented with a few irregularly-placed, obscure, direct, upright ribs. Ventral area arched, divided by a small, probably solid carina. Inner margin well-marked, broad, steeply sloped, tending to become concave with age. Inclusion about five-eighths. Umbilicus concentric—the central whorls ornamented with only a few small spines and irregularly-placed bullicostæ, the outer whorls with plain, somewhat distant, rather irregular and obscure ribs.

Up to about 110 mm. in diameter the form is thin, but afterwards it becomes more than proportionately thicker. The same feature is seen in *crassinuda* α, but not to the same extent, because it is thicker to begin with.

The greater compression of the adolescent shell in relation to the size of the umbilicus, and the very little development of spines in the inner whorls, separate this form from the varieties of *crassinuda;* but the greater proportionate compression links it to *diversa* through the form shown in Pl. LXXXI, figs. 5, 6.

That the immature form is thin and umbilicate seems to negative derivation from *crassinuda*, but to suggest descent from *diversa* by way of that intermediate form. Yet the deficiency of central spines—the feature which makes *lævigata* an aberrant form of the *crassa*-stock—is a difficulty. Still, in the intermediate form the spinous stage is very short, on account of the absence of the irregular spinous stage; and perhaps the law of modification of earlier inheritance would account for the development of *lævigata* from such a form. This is the best suggestion I can make with regard to the genealogy of this peculiar specimen.

Sonn. lævigata is a scarce fossil in the *Concavum*-zone of Bradford Abbas. A portion of its side view illustrating the coiling and ornamentation of the umbilicus is shown in fig. 5 of Pl. LXXXII; and the section of the whorl in outline (restored), from a little behind the aperture, is given in fig. 6.

The *subdecorata*-stock.

Four dwarf forms, which appear to illustrate retrogressive development and earlier inheritance in a very striking manner, are included in this series; they may be distinguished from one another thus :

S. subspinosa, spinous and spinicostate.

S. decorata, spinicostate and nodicostate.[1]

S. subdecorata, spinicostate and costate.

S. decora, costate.

In a recent paper[2] Mr. F. A. Bather, F.G.S., and myself have proposed a series

[1] Nodicostæ differ from bullicostæ in having less elongate protuberances—often because the "nodi" are truncate on the outside. The "nodi" may be not unlike pimples—nearly round. Like bullicostæ, the nodicostæ are a degenerate form of spined rib (spinicostæ), and the "nodi" mark a phase of decadence between spines and no spines.

[2] "The Terms of Auxology," by S. S. Buckman, F.G.S., and F. A. Bather, M.A., F.G.S. ('Zoologischer Anzeiger,' Nos. 405–6, p. 420, November, 1892). We pointed out the etymological objections to the biological terms proposed by Prof. Hyatt, and used by American and other authors; but, fully recognising the great value of some such terms, we suggested the series shown in the following table—the life of an individual being divided into six stages, as in Hyatt's scheme. Further we remarked that the stages of phylogeny could be designated in the same manner by the prefix of "*phylo-*" and that the stages, during phylogenetic history, of the growth and decline of a character (morphogenesis) could be distinguished by the same terms with "*morpho-*" as a prefix. The table below also gives Haeckel's physiological terms for growth, perfection, and decline in ontogeny and in phylogeny.

	Ontogeny.	*Phylogeny.*	
Anaplasis	Embryonic	Phylembryonic	Epacme.
	Brephic[1]	Phylobrephic	
	Neanic[2]	Phyloneanic	
Metaplasis	Ephebic[3]	Phylephebic	Acme.
Cataplasis	Gerontic[4]	Phylogerontic	Paracme.
	Catabatic[5]	Phylocatabatic	
	Hypostrophic[6]	Phylhypostrophic	

It should be noted that the gerontic stage is subdivided into two; namely, Catabatic, "the period of decline," and Hypostrophic, the stage of atavic senility—the stage when prolonged decline causes pronounced reversion. No words in our language really give expression to these phenomena. In regard to "Epacme," &c., it should be noted that these terms refer, properly, to number of species, and to individual size and predominance: by many writers, however, they have been used in relation to phylogenetic development, obviously for want of the very terms we proposed. In regard to the application of our terms to Ammonites, attention may be called to "Études sur les Ammonites des Étages moyens," par Émile Haug ('Bull. Soc. géol. France,' 3e série, t. xx, p. 301, &c.); where, however, it appears that the distinction between ontogenetic and phylogenetic stages is not quite maintained.

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[1] Βρεφικός, belonging to the unborn or new-born young. [2] Νεανικός, adolescent. [3] Ἐφηβικός, adult. [4] Γεροντικός, senile. [5] Καταβατικός, affording an easy descent. [6] Ὑποστροφή, a recurrence or relapse.

of terms by which a more complete analysis of specific characters and their biological significance can be stated with greater precision, and in fewer words, than has hitherto been in any degree possible. With these terms the characters of these forms can be stated thus :

Species.	*Brephic stage.*	*Neanic stage.*	*Ephebic stage.*
S. subspinosa	Regular spines	Plain ribs, and at intervals spined ribs (irregular spinous stage)	Plain ribs, and at intervals spined ribs (spinicostæ), declining to knobbed ribs (nodicostæ).
S. decorata	Do.	Costæ and spinicostæ	Costæ and nodicostæ, followed by plain costæ.
S. subdecorata	Do.	Do.	Costæ.
S. decora	Do. ?[1]	In the early part costæ and nodicostæ, later costæ only	Costæ.

From this table the earlier inheritance of the ornamentation of the ephebic stage of *subspinosa* may be traced until this ornament appears in the early neanic, or perhaps even late brephic stage of *S. decora*, which stage is thus the morphological representation of ephebic *subspinosa*. All the species show various phases of phylocatabatic development after their brephic stages. The decline becomes very pronounced in *S. decora;* but the phylhypostrophic stage is not reached in this stock, because by analogy with other series it may be known that the form belonging to that stage would be smooth and keelless.

The species of the *subdecorata*-stock are the morphological equivalents, on a small scale, of *S. crassispinata* α, *irregularis*, *submarginata*, and *subcostata*. That they are not the young of these species may be seen by certain external differences of ornament and proportion. That they belong to a stock very different from *submarginata* may be learnt from the possession of a longly-lobate suture-line in correlation with the costate stage—for instance, in *subdecorata*. This suture-line, so different from that of *submarginata*, indicates that the *subdecorata*-stock is only distantly related thereto, but that it is nearly allied to a series which will be described presently. In regard to descent the *subdecorata*-stock will appear to be a separate derivation from *multispinata*, or from the morphological equivalent thereof.

Sonninia subspinosa, *S. Buckman.* Plate XLIX, figs. 8, 9; Plate LXXXIV, figs. 4—6.

Discoidal, compressed, hollow-carinate. Whorls ornamented in the brephic

[1] Details obscured by tool during removal of matrix.

stage with regular spines, in the neanic and ephebic stages with costæ and irregularly-placed spinicostæ—the latter usually parted by two to four costæ; a single rib leads to the spine and bi- or trifurcates beyond: with age the spines decline to knobs. Ventral area arched, divided by a small but well-defined hollow carina. Inner margin ill-defined, steep. Inclusion about one-third—the overlap up to the spines. Umbilicus with a spinous and rather deep centre, later on shallower, with ribs and spines. Whorl-section elliptical. Septa complex, the lobes long, and fairly ornate; the superior lateral lobe asymmetrical.

This species has much resemblance to the young of *Sonn. crassispinata* α, but is distinguished by less elaborate ornamentation—both spines and ribs being smaller and closer together, and the ribs being more numerous. Yet it can scarcely be the descendant of *Sonn. crassispinata* α, because it does not show the consequential changes which should appertain to the offspring of the latter in accordance with earlier inheritance. In fact, *subspinosa* has the same whorl-shape as *crassispinata* α, and its ornamentation is of similar pattern though so different in the strength of its details. It is, therefore, more reasonable to conclude that the two species are cousins, and to suppose, for the *subdecorata*-stock, a separate derivation from *multispinata*—a dwarf series, according to the evidence before me, which attained to scarcely larger dimensions than the specimen depicted.

I figured the inner whorls of this species for the young stages of *Sonn. acanthodes*;[1] but this was before the collection of Mr. Darell Stephens furnished older examples, showing that the slight initial differences in the intensity of ornament became more pronounced with age, and should not be overlooked. Owing, however, to the close genealogical relationship between this species and *acanthodes*, the young of this species answered the purpose of illustrating the brephic ontogeny of that one, and for all practical purposes will serve the same end now.

Sonn. subspinosa is a rare fossil from the *Concavum*-zone of Bradford Abbas, Dorset.[2] It has a somewhat deceitful resemblance to certain species of *Hammatoceras*, found at about the same horizon; but its septa show that it does not belong to that genus, and that it is a *Sonninia*.

The side and front views of *Sonn. subspinosa* are shown in Pl. LXXXIV, figs. 4, 5; the suture-line, fig. 6. In Pl. XLIX, figs. 8, 9 give various details concerning the brephic stage of this species. It will be noticed that the whorl-section is, at first, depressed pentagonal, with a tendency to flatten the ventral

[1] 'Quart. Journ. Geol. Soc.,' vol. xlv, pl. xxii, figs. 22, 23.

[2] As Dorset and Somerset are not shires of a county town, like Gloucester-shire, Oxford-shire, Wilt-shire (Wilton-shire), but are the lands of the Dornseatas and Sommerseatas, the word "shire" should not be added to them any more than it should to Cornwall, Kent, Essex, Northumberland, &c.

area, expand the sides, and so become depressed obtriangular.[1] Compression of the sides produces, later on, a peroval whorl-section (Pl. XLIX, fig. 9), and further compression produces the oval "aperture" of the adult.

Sonninia decorata, *S. Buckman.* Plate LXXXIV, figs. 7, 8.

Discoidal, compressed, hollow-carinate. Whorls ornamented in the brephic stage with regularly-set spines, in the neanic stage with reclining ribs, of which, at first, about every third, later, about every fifth, carries a spine; in the ephebic stage with reclining, direct, ventrally-inclined ribs, of which, at first, about every fifth carries a spine—the rib breaking into two or three outside the spine; later, every second or third rib is slightly nodate at its middle, sometimes bifurcating beyond; and, later still, there are irregular-sized ribs with occasional obscure bifurcation. Ventral area subacutely arched, divided by a small, well-defined hollow carina. Inner margin ill-defined, subconvex. Inclusion about two-fifths. Umbilicus open, at first regularly, later irregularly spinous. Whorl-section ovate.

It is assumed that the specimen figured is adult. In relation to *Sonn. subspinosa*, it stands just one remove in accordance with earlier inheritance and retrogressive development; it is distinguished from that species by its thinner form and the early decadence of the spines. It is unfortunate that I cannot give the suture-line of this species, but none of my specimens show it.

Sonn. decorata, though somewhat differently ornamented, has a general resemblance to *Sonn. submarginata*, but it is a much thinner shell with a more acute ventral area. The sharper ventral area is important—it indicates greater retrogression, either phyletic or ontogenetic; it is, in fact, a gerontic or a phylogerontic character. In other words, in retrogressive development the periphery becomes more acute with age in the individual or in the race owing to whorl-compression. Therefore the flatter-abdomened but older *submarginata* could not be the adult of the more acute-abdomened *decorata*.

The *Concavum*-zone of Bradford Abbas, Dorset, has yielded the examples in my cabinet. It is presumably not a rare species, though possibly somewhat uncommon. Two views, side and front, of this species are given in Pl. LXXXIV, figs. 7, 8.

[1] Inverted triangle—the narrowest part towards the centre of the shell.

Sonninia subdecorata, *S. Buckman.* Plate LXXXIV, figs. 9—11.

Discoidal, compressed, hollow-carinate. Whorls ornamented in the brephic stage with regular spines, in the neanic stage with costæ, and at intervals spines; in the ephebic stage with small, closely-set, direct, nearly upright, ventrally-inclined costæ, occasionally connate on the inner third of the whorl. Ventral area subacutely arched, divided by a small, well-defined hollow carina. Inner margin ill-defined, subconvex. Inclusion about two-fifths. Umbilicus shallow. Whorl-section subelliptical. Suture-line with long, narrow-stemmed, ornate lobes —the superior lateral asymmetrical.

The suture-line of this species shows that it has no connection with the *submarginata*-group—the narrow-stemmed and somewhat elaborate lobes indicate considerable anatomical differences; and, in fact, like the last, it is differently ornamented and thinner.

From *decorata* this species differs by the much smaller size of its more closely-set ribs, by the ribs being occasionally connate on the inner third instead of bifurcate towards the outer third of the whorl, by its thinner shape, and by the absence of nodicostæ. It is presumably the descendant of *decorata*, showing further retrogression.

Sonn. subdecorata is not a common species, though several specimens have been obtained at Bradford Abbas, Dorset, in the *Concavum*-zone. In figs. 9, 10, of Pl. LXXXIV are shown the side and front views of a specimen with well-preserved test; the suture-line, fig. 11, is from another specimen.

Sonninia decora, *S. Buckman.* Plate LXXXIV, figs. 12—14.

Discoidal, compressed, hollow-carinate. Whorls ornamented with numerous, small, direct, slightly-reclining, ventrally-inclined ribs,[1] occasionally obscurely connate on the edge of the inner margin. Ventral area not defined, arched, divided by a small, well-defined hollow carina. Inner margin scarcely defined, steep. Inclusion about three-eighths. Umbilicus with a very slight excentric appearance. Aperture elliptical. Suture-line somewhat ornate.

This species is, when adolescent, so exactly the morphological representation of adult *subdecorata*, that I have little hesitation in placing it in this connection.

[1] The details of just the centre have been obscured by the tool in cleaning, but some nodicostæ may be detected in youth.

The suture-line is the only matter for doubt; for the superior lateral lobe is scarcely so branched, and is rather wider-stemmed than would be expected. Perhaps degeneration of the septa, which is often a phylocatabatic feature, may account for this. Such a surmise seems supported by the suture-line at an earlier age, when, as seen through the crystalline test, it is narrower-lobed and proportionately more ornate.

Of this interesting little species there is in my cabinet only one specimen, obtained from the collection formed by Mr. Darell Stephens, F.G.S., &c. It is from the *Concavum*-zone of Bradford Abbas. Side and front views, and suture-line are illustrated in Pl. LXXXIV, figs. 12—14.

The *omphalica*-stock.

In this stock are two forms distinguished by the large size of the umbilicus in correlation with somewhat compressed whorls, considerable decline in ornamentation, and a degraded type of suture-line. They belong to the costate stage of phylocatabatic development, and illustrate two gradations of decline. From each other they may be separated thus:

S. euromphalica, centrally spinous, costate.

S. omphalica, rudimentary spines, costate.

The simple septa, with asymmetrical superior lateral lobes, of *Sonn. euromphalica* suggest connection with the *submarginata*-stock; the more degraded septa of *Sonn. omphalica*, with their almost aborted lateral lobules, have resemblance to the septation of *Sonn. costata*. The general proportions—considerable compression correlated with wide umbilication—are similar to what obtains in both the *submarginata*- and *costata*-stocks; but the spinosity correlated herewith is too much for descent from *S. costata*, and too little for descent from *S. submarginata;* regard, of course, being paid to the amount of compression and the width of umbilicus with which a given degree of spinosity is associated in these cases.

Sonninia euromphalica,[1] *S. Buckman.* Plate LXXXV, figs. 1—3.

Discoidal, compressed, hollow-carinate. Whorls ornamented, at first, with fair-sized regular spines, which presently are irregular, and then die away—only

[1] Εὐρύς, broad; ὀμφαλός, umbilicus.

an occasional rib being a little bullate: the greater part of the fossil ornamented with direct, slightly-reclining, ventrally-inclined ribs. Ventral area, with test, flattened, almost medianly-sulcate,—the depression divided by a small, well-defined hollow-carina: without test, carinate-bisulcate, the carina small, the sulci unmistakable. Inner margin ill-defined, steep. Inclusion about one-third. Umbilicus open, graduate. Whorl-section nearly quadrate. Suture-line simple, with rather broad-stemmed lobes.

This form, the morphological equivalent of *Sonn. submarginata*, to which it has much resemblance, differs in its shorter spinous stage, coarser ribbing, flatter, squarer ventral area, and more quadrate whorls. It is more likely to be confounded with *Sonn. cymatera* until the eye has become expert to detect the difference in the reclination of the ribbing—so marked a feature of that species. *Sonn. euromphalica* is, however, also distinguished from *cymatera* by its smaller ribs more closely set—as three to two,—by its flat-sided whorls, steeper inner margin, and by having more of the regular and fewer of the irregular spines.

In Pl. LXXXV, figs. 1—3 give side and front views and suture-lines of this species, which is from the *Concavum*-zone of Bradford Abbas, Dorset. It is doubtful if it be an adult shell, but it is unlikely that it reached a large size. The specimen is almost complete—it has half a whorl of body-chamber.

SONNINIA OMPHALICA, *S. Buckman.* Plate LXXXIII, figs. 5—9.

Discoidal, compressed, carinate. Whorls ornamented, in the brephic stage, with small regular spines, soon yielding to spines and ribs, passing in the neanic stage to ribs and nodicostæ, and then to plain costæ; the presumably ephebic stage with fairly-marked, somewhat distant, rounded, direct, slightly-reclining, ventrally-inclined (almost ventrally-projected) ribs. Ventral area, neanic, almost sulcate, divided by a well-marked, presumably hollow carina; ephebic, somewhat flattened, divided by a small, rounded carina,[1] which tends to become obsolete in the middle of a more sloped area. Inner margin not defined till the plain costate stage is well commenced, then smooth and steep, later on more sloped. Inclusion about two-fifths. Umbilicus shallow, open, graduate. Whorl-section, neanic, subcircular; ephebic, elliptical. Suture-line simple, with broad-stemmed lobes; in the superior lateral lobe the lateral lobules are presumably aborted, the cruciform arrangement not being shown.

This species is chiefly remarkable for the size of its umbilicus in proportion to

[1] There is a slight tendency to form a crenulate carina on the early part of the body-chamber.

compression, and for its very simple suture-line. These characters bring it into connection with *costata* and with *submarginata ;* but it is more slowly coiled, more umbilicate, more numerously ribbed, less graduate in the umbilicus, less lobate, and thinner than the first ; while it is less centrally spinous, more coarsely ribbed, with a more angular ventral area, and more degraded lobes than the second.

From *euromphalica* it differs in having a smaller, shorter spinous stage, a slightly smaller umbilicus, and in being more compressed ; in fact, the changes are such as would be expected in retrogressive development by earlier inheritance. It is, therefore, presumably the descendant of *euromphalica*. Practically it agrees with it in suture-line, that is if it be supposed that there has been degeneration in the suture-line as well as in other features, and that the lateral lobules of the superior lateral lobes have become so aborted as to be detected only with difficulty. The degraded type of suture-line in comparison with that of other *Sonniniæ* is certainly very noticeable.

Sonn. omphalica is a somewhat rare form from the *Concavum*-zone of Bradford Abbas. A presumably adult specimen is depicted in Pl. LXXXIII,—side view fig. 5 (the spinous stage of its inner whorls has suffered somewhat from the tool in cleaning), front view fig. 6, and suture-line fig. 7. The side view of a young specimen (fig. 9 of the same plate) illustrates the spinous stages ; its front view is shown in fig. 8.

The *quadrifida*-stock.

The species of this stock are noticeable, particularly, for the balance maintained in the proportions of the superior lateral lobe. The lobe is, therefore, symmetrical ; and the cruciform arrangement is evident. The terminal lobule is axial,—that is, it forms a continuation of the main axis of the lobe ; it is isosceloid, —because the axil on either side is equally distant from the tip ;[1] and it is equicellate,—that is, the cells separating it from the inner and outer lobules are of equal size and depth. The lateral lobules are equipoised,—that is, they are both much of the same size and " opposite " (springing from the lobe at points opposite to each other) ; and they are both more or less bipartite. The bipartition becomes most noticeable in *Sonn. papilionacea*, where it causes the two lateral lobules to form a rude ⋈. In all the species the terminal lobule is rather long, rather narrow, and not much branched.

[1] If, without taking account of the offshoots, straight lines be drawn from each axil to the tip, and the two axils be similarly connected, an isosceles triangle is formed, of which the line between the axils is the base.

Sonninia spinosa, *S. Buckman*. Plate LXXXI, figs. 7—9.

Discoidal, compressed, hollow-carinate. Whorls ornamented with rather small, direct, nearly upright, ventrally-inclined ribs of different sizes: of the larger, which occur at irregular intervals, each one carries a median spine, and often bifurcates beyond it. (The regular spinous stage persists until the specimen is about 25 mm. in diameter.) Ventral area arched, carrying a small, fairly-defined hollow carina. Inner margin fairly defined, steeply sloped. Inclusion about three-eighths—almost up to the spines. Umbilicus concentric, somewhat deep, graduated, ornamented with ribs and spines. Whorl-section elliptical, about one-fifth indented. Suture-line with a symmetrical superior lateral lobe; the lateral lobules equipoised, the terminal lobule axial and isosceloid.

At a fairly early period of growth the spines are long, rather taper, and sharply elevated; but later on they decline in elevation, so that the ribs which are only knobbed, would be technically called bullicostæ.[1] The spines or knobs are set rather on the inner half of the whorl, so that, though the inclusion is considerable, there is still a slight space between the spines and the inner margin of the succeeding whorl. The position of the spines and the amount of inclusion give a small umbilicus, relatively to similarly ornate species, in correlation with somewhat elaborate ornament; and such a combination of characters at once distinguishes this from any of the correspondingly spinous species described.

Sonn. spinosa is the morphological equivalent of *acanthodes*, *irregularis*, and *crassiformis*; but it is separable from any of these by the combination of characters mentioned above, as well as by the smaller size of its spines. Further, it is distinguished from *acanthodes* by its upright ribs and greater inclusion; from *irregularis* by less elaborate ornament; from *crassiformis* by the spines not being regular—ribs with and without spines being somewhat irregularly alternate in the present species.

The specimen figured as the type is not adult. In my collection there is an example 195 mm. in diameter, and it is septate to 176 mm.; and therefore it would probably have measured 240 mm. when complete. There is no reason to suppose that this is the largest size to which the species attained, though it agrees fairly with the size of allied species. This specimen shows that there is further decline in the size of the bullicostæ, and then a slight increase later on. It suggests, too, that the last knobbed rib shown in the type (just under fig. 9 of the plate) is possibly abnormal. Further, it affords evidence that without the test the bullicostæ are not to be observed—the specimen appears to have merely plain

[1] On the ribs which bifurcate the elevations are more like nodi.

costæ. In this, as in some other allied species, the bullicostæ are mere thickenings of the test, and there are consequently no corresponding elevations of the core. This fact, as well as the analogy with other species, indicates preparation for a plain costate test—it is a sign of retrogression.

In identifying specimens with this species it is necessary to give a word of warning. Apparent similarity of ornamentation, especially in the young stages, is misleading. The similarity of ornament must be accompanied by a suture-line, with an isosceloid, equicellate terminal lobule to the superior lateral lobe, which should itself be fairly symmetrical. The delineation of the suture-line of the type is not altogether satisfactory, owing to indifferent preservation of the core: this has given the lobes and lobules a greater breadth of stem than they would properly possess, and some of the minor details are obscured.

Sonn. spinosa occurs in the *Concavum*-zone of Bradford Abbas. The type-specimen, a fairly well-preserved example with the greater portion of its test present, is illustrated in side view, fig. 7, Pl. LXXXI; the outline of its whorl-section in fig. 8; and its suture-line in fig. 9.

Sonninia quadrifida, *S. Buckman*. Plate XCI, figs. 1—3.

Discoidal, compressed, hollow-carinate. Whorls ornamented with direct, fairly-close, not prominent, almost upright,[1] ventrally-inclined costæ, which become more distant[2] after about 145 mm. diameter. (The regular spinous stage lasts to about 30 mm., the irregular spinous stage to about 45 mm. diameter.) Ventral area arched (in adult the median part somewhat flattened), divided by a well-defined, rounded hollow carina, which, with age, becomes less conspicuous, smaller, and more impressed. Inner margin not well-defined till the early costate stage, then steeply sloping, subconvex; the portion abutting against spines formed with niches for their reception (indented for spines). Inclusion about three-tenths. Umbilicus slightly excentric—after about 130 mm. diameter. Whorl-section oblong. Suture-line with a symmetrical, cruciform superior lateral lobe, of which the lateral lobules are equipoised and bipartite; while the terminal lobule is long, taper, axial, equicellate, and isosceloid.

The nearest morphological equivalents of this species, though several of them show less difference in relative proportions of costate and spinous stages—that is,

[1] Rather more reclinate on the last half-whorl.

[2] On the core the costæ are rather prominent, but where the test is present they are no more prominent than before.

if the costæ are similar the spines are smaller—are those given below; and their differences may be stated thus:

Sonn. dominans, type[1] (Pl. LXVI), is thicker, less spinous, more umbilicate.

Sonn. revirescens (Pl. LXX, fig. 1) is less costate (in earlier stage), less umbilicate, less carinate, sharper ventrally.

Sonn. submarginata (Pl. LXXI, figs. 1—3) is more umbilicate, less spinous—the spines more irregular,—and has an asymmetrical superior lateral lobe.

Sonn. semispinata (Pl. LXXVII, figs. 1, 2) is thinner, more angular, less spinous, more costate—the costæ obsolescent with age,—less carinate.

Sonn. crassa (Pl. LXXXII, figs. 1, 2) is far thicker, less umbilicate, more coarsely ornamented.

Sonn. diversa (Pl. LXXXIII, figs. 1, 2) is more costate, and has a larger number of more closely-set spines.

The agreement in the matter of suture-line causes me to place this species as the descendant of *spinosa*, though there is, obviously, room for several intermediate species. The four points made by the bipartition of the lateral lobules suggest the name *quadrifida*.

The reduced size at which this species has been figured, necessitated by the desire not to carry any of the *Sonninin*æ of the *Concavum*-zone into Vol. II, has given the shell a somewhat false appearance, and its identification is accordingly rather more difficult. In this connection, however, it may be noted that the features of the suture-line are a very sure guide: the symmetry of the superior lateral lobe and its bipartite lateral lobules are very noticeable.

Sonn. quadrifida occurs in the *Concavum*-zone of Bradford Abbas. The side view of the type-specimen is illustrated in fig. 1 of Pl. XCI; and in fig. 1 *a* is given a further portion of the end of the whorl (it is broken away in fig. 1), showing that the ribs of the core are becoming larger with age. The outline of the front view is given in fig. 2 (*a*—*a*): the figs. 1, 1 *a*, and 2 are half natural size. Two consecutive septa, ultimate and penultimate, are shown in fig. 3; they are of natural size.

SONNINIA PAPILIONACEA, *S. Buckman*. Plate XC, figs. 1—3.

Discoidal, compressed, carinate. Whorls ornamented with direct, closely-set, inconspicuous, upright, ventrally-inclined costæ, which tend to become rather more distant and a little more prominent after about 120 mm. diameter. (Spinous stage ends about 28 mm. diameter.) Ventral area rounded, slightly flattened,

[1] It will be explained later on why only the type *dominans* is mentioned.

divided by a small ill-defined (hollow ?[1]) carina. Inner margin well defined, nearly upright (later, falling off a little more), subconvex. Inclusion about three-tenths. Umbilicus decidedly excentric (beginning at about 27 mm. umbilical diameter, about 90 mm. diameter of the shell), at first small and somewhat deep. Whorl-section oblong (slightly ventrally convergent). Suture-line with a symmetrical, cruciform superior lateral lobe, of which both the outer and the inner lobules are nearly equipoised and distinctly bipartite; the terminal lobule long and tapering, axial, equicellate, and isosceloid.

The long, taper terminal lobules and the bipartite, equipoised, laterally-projected lateral lobules have a certain resemblance to the shape of the abdomen and wings of various Lepidoptera. Hence this type of superior lateral lobe may be called "papilioniform," and the species "*papilionacea*."

The only species at all like this one are *Sonn. substriata* and *Sonn. parvicostata;* but both of them differ entirely in their septation. Further, this species is more costate than either of them.

The agreement in suture-line, costation, and general appearance warrants my placing this species as the descendant of *Sonn. quadrifida*. It differs only in the features which the development of that species would possess,—that is to say, it is less spinous, less costate, and less umbilicate—the excentricity of the umbilicus being apparent at an earlier age. In comparing this species with *Sonn. quadrifida* in regard to earlier inheritance it may also be noted that larger costæ—larger, that is, than their predecessors—make their appearance in this species at a rather earlier age than in that one.

Sonn. papilionacea occurs in the *Concavum*-zone of Bradford Abbas. The side view of the type-specimen, reduced to one-half natural size, is shown in fig. 1 of Pl. XC; the outline of the whorl-section, similarly reduced, in fig. 2; the septa in fig. 3. The lettering of this figure suggests the correlation of homologous parts in this and two other superior lateral lobes of very different types; further, this lobe may advantageously be compared with another type of superior lateral lobe belonging to an outwardly homœomorphous fossil, namely, fig. 6 (Pl. XC).

The *paucinodata*-stock.

Externally the various species of this stock may be at once separated from their respective morphological equivalents in the *quadrifida*-stock by being, relatively to retrogression in other characters, less spinous. Thus *Sonninia nodata*, which in its general characters has made far less departure towards the

[1] The core is practically uncarinate until the body-chamber is reached.

attainment of the compressed, involute form than *Sonn. spinosa*, has yet gone further in the matter of loss of spines; and these differences are maintained in the development of the descendants of these two species.

Internally, in the matter of suture-line, there is a particular distinction between the members of the *paucinodata*- and *quadrifida*-stocks. In the former the superior lateral lobe has a decided want of symmetry, on account of the cell parting the outer and terminal lobules being considerably deeper than the cell parting the terminal and inner lobules; and consequently, the lateral lobules are not opposite,—that is, the inner lobule, in this case, leaves the main stem further back than does the outer lobule. Technically, then, the superior lateral lobe in this series is asymmetrical on account of the terminal lobule being intra-axial,[1] distinctly anisosceloid, and inequicellate. In the *quadrifida*-stock the superior lateral lobe is symmetrical, the terminal lobule axial, isosceloid, and equicellate (see page 364).

SONNINIA NODATA, *S. Buckman*. Plate LXXXIX, figs. 1—3; and allied young form, Plate LXXXIX, figs. 4, 5.

Discoidal, compressed, hollow-carinate. Whorls ornamented with rather small, not prominent, subarcuate, much reclined, ventrally-inclined costæ, of which about every second or third carries a small median knob—the knob-bearing costæ more prominent than their fellows. (The regular spinous stage lasts to a diameter of about 25 mm., then follows an irregular spinous stage—spinicostæ to costæ about as one to three—to about 70 mm. diameter; to this succeeds the stage when every second or third costa is nodate; later still the nodicostæ are more numerous.) Ventral area obtusely arched, medianly flattened, bearing a small, fairly-defined, sub-impressed hollow carina. Inner margin practically undefined. Inclusion about one-third, not up to the spines. Umbilicus concentric, with gibbous-sided whorls. Whorl-section oval. Suture-line with an asymmetrical superior lateral lobe; the terminal lobule intra-axial, distinctly anisosceloid and inequicellate; the lateral lobules not opposite.

Compared with *Sonn. spinosa* this species is less elaborately spined, more roundly whorled, and more umbilicate. It cannot be derived, therefore, from *Sonn. spinosa;* because, while the degree of spinosity is more retrograde, the other features are less so than in that species. For opposite reasons *spinosa* cannot be derived from this species: further, any such idea of derivation is at

[1] Intra-axial, inside the line of the main axis; if outside it would be ultra-axial.

once negatived by the septation; for in *Sonn. nodata* the superior lateral lobe has lost its bilateral symmetry; in *Sonn. spinosa* the symmetry is maintained.

In whorl-shape *Sonn. nodata* is like *Sonn. crassispinata*, but it is much less spinous, and differs in septation. The combination of round whorls, small spines, and reclinate ribs separates it from any other species.

The type-specimen of this species, an almost wholly-septate example, is shown in Pl. LXXXIX—side view, fig. 1; front view in outline, fig. 2; and parts of two suture-lines, fig. 3. In the same plate a young shell has been drawn—side view, fig. 4, and front view, fig. 5. It may be remarked that this young shell does not agree exactly with the inner whorls of the type, because it has rather smaller spines. It can scarcely, therefore, be considered as the actual young of the type *nodata*, though it is sufficiently close to give a good idea of what the young shell would be. Strictly speaking, it is, no doubt, the young of a species which joins *nodata* to *paucinodata*, a form of which I have not yet obtained an older example. It has a likeness to *Sonn. subspinosa* (Pl. LXXXIV, figs. 4, 5), but may be at once separated therefrom because of the difference in ribbing on the area between the spines and the carina. In this form bifurcation is rare; in *Sonn. subspinosa* trifurcation is common.

SONNINIA PAUCINODATA, *S. Buckman.* Plate XCI, figs. 7—9.

Discoidal, compressed, carinate. Whorls ornamented with small, subundulate, direct, upright, ventrally-obsolete costæ. (The spinous stage ends at about 35 mm. diameter). Ventral area arched, divided by a small, indistinct, ill-defined carina; core carinate. Inner margin rather ill-defined, subconvex, fairly sloped. Inclusion about one-half. Umbilicus excentric, graduate, costate, centrally spinous. Whorl-section oblong, about one-fifth indented. Suture-line with an asymmetrical superior lateral lobe, the lateral lobules not opposite, the terminal lobule intra-axial, anisosceloid, and inequicellate.

This species has externally some resemblance to *Sonn. quadrifida;* and the reduced size at which the forms have been depicted in the plate has given a false impression, by considerably heightening this likeness. However, *Sonn. paucinodata* is less carinate, less spinous, on the whole more costate, slightly thinner, and certainly less marginate than *Sonn. quadrifida.* Internally the septa are very different (see page 369). Septation, again, distinguishes this species from *Sonn. papilionacea*, while, externally, the more marked costation of the early costate stage is a sufficient distinction.

The upright ribs, or the excentric umbilicus, or the longer duration of a pro-

nounced costate stage, or, lastly, the septation—one or more of these features will distinguish this species from any other morphological equivalents.

The present species has two features linking it to *nodata*, which suggest its position as a descendant of that one. First, it possesses the same want of symmetry in the superior lateral lobe; and secondly, it has an ill-defined inner margin. The inner margin is more defined than in *nodata*,—that is the course of development consequent on less gibbous whorls; but it is not so well defined as in the nearest morphological equivalents.

Sonn. paucinodata occurs in the *Concavum*-zone of Bradford Abbas. Fig. 7 of Pl. XCI shows the side view of the type-specimen, reduced to one-half natural size; fig. 8 gives the outline of the front view similarly reduced; fig. 9 illustrates parts of two septa of natural size. To facilitate comparison these figures have been placed on the same plate as similar figures of *Sonn. quadrifida*—the only species for which the present one could be mistaken.

SONNINIA ATTRITA, *S. Buckman*. Plate XC, figs. 4—6.

Discoidal, compressed, carinate. Whorls nearly smooth, ornamented only with obscure, undefined folds. (In the umbilicus a spinous stage persists to a diameter of about 25 mm. [umbilical diameter 16 mm.]; about another whorl is costate; then the costæ are obsolescent.) Ventral area fairly defined, somewhat flattened, divided by a small, ill-defined carina. Inner margin fairly defined, sloping. Umbilicus graduate, excentric. Inclusion more than one-half. Whorl-section oblong, more than one-fourth indented. Suture-line with an asymmetrical superior lateral lobe; the terminal lobule intra-axial, anisosceloid, inequicellate; the lateral lobules not opposite.

The suture-line of this species possesses a superior lateral lobe with the same features which characterise those of *paucinodata* and *nodata*—want of symmetry on account of the intra-axial position of the anisosceloid terminal lobule. Therefore this species may be united with the *paucinodata*-stock, as a descendant of *paucinodata*; and its ornamentation—or want thereof—exactly conforms to what would be expected from the further development of that species.

In regard to species of other stocks, the spinous centre separates it from most of the similar, nearly smooth forms; the suture-line separates it from *modesta*. The suture-line, particularly, distinguishes it from *Sonn. papilionacea*; but it also differs externally, in the section of its outer whorl, in being less umbilicate and less costate—the costæ in the early costate stage are nearly twice as distant, and yet hardly more prominent.

Sonn. attrita is the form alluded to at page 340 as not unlike *parvicostata*, but as probably belonging to a different stock. Since then, some portion of the test has been successfully removed; and it is now possible to say to what stock it does belong, on the evidence of its suture-line. It may be remarked that the want of symmetry in the superior lateral lobe prevents this form being included in the *costata*-stock; while external differences from *S. parvicostata* are the spinous centre and the smaller umbilicus—these features alone point to a difference in ancestry.

Sonn. attrita occurs in the *Concavum*-zone of Bradford Abbas. In Pl. XC, fig. 4 shows the side view, one-half reduced, of a partially-shelled specimen with half a whorl of body-chamber; fig. 5, the outline of the front view similarly reduced; fig. 6, the suture-line with its asymmetrical superior lateral lobe, of natural size.

Species of different Stocks.

The following species, from the combination of characters they possess, appear to be somewhat isolated,—at any rate, they cannot be placed in any of the preceding stocks. They are very different from each other, and the only bond between them is their respective isolation, from not possessing any close allies. Such forms will no doubt appear in time; for it is noticeable that since the following articles were first penned several species have been removed from this association: by continued work allied forms have been discovered, and the species could no longer be treated as *incertæ sedis*. For several reasons the description of such species is conveniently postponed until their allies are figured.

SONNINIA PALMATA, *S. Buckman*. Plate XC, figs. 7—9.

Discoidal, compressed, hollow-carinate. Whorls ornamented with direct, reclining, ventrally-inclined, undulate, not very conspicuous costæ, which become considerably more distant on the last whorl. (The irregular spinous stage ends at about 60 mm. diameter.) Ventral area arched, divided by a small, distinct hollow carina. Inner margin narrow, rising steeply, but upper edge much rounded off. Inclusion about one-third. Umbilicus with slightly gibbous whorls, of which the earlier are ornamented with spines and ribs. Section of last whorl elliptical. Suture-line with a bifid superior lateral lobe—the outer portion

tridactyloid, the inner bidactyloid—deeply divided by the outer interlobular cell;[1] the outer lobule (*A*) of the superior lateral lobe greatly exaggerated and tripartite; the terminal lobule (*B*) very intra-axial, very anisosceloid, and very inequicellate; the inner lobule (*C*) greatly abbreviated, very anisosceloid, partly coalesced with the terminal lobule, and feebly bipartite.

The most noticeable feature in this species is the large superior lateral lobe. Of its unduly exaggerated outer lobule (*A*), the portion marked a^1 (Pl. XC, fig. 9) is the homologue of the principal point of the outer lobule in other species; but in the present case, instead of being continuously projected from the side of the lobe, it is exceptionally dependent, whereby it almost apes the terminal lobule (*B*). The outer lobule has not only increased by extending a side-shoot, a^2, but it has developed a further accessory shoot, a^3; and it would be difficult to say whether a^2 or a^3 be the homologue of the upper shoot in such a species as *papilionacea* (Pl. XC, fig. 3). As may be seen by the lettering, it is suggested that a^2 in fig. 9 and fig. 3 are homologous.

The homologue of the terminal lobule of other species is the lobule lettered *B*. That such is the case, and that this lobule is in a somewhat degenerate condition, may be learnt by comparison with the suture-lines of *Sonn. gibbera* and *Sonn.* sp. (Pl. LXXXVIII, figs. 1—4). These suture-lines show the terminal lobule partly joined with the inner lobule, and they indicate that further abbreviation of the inner lobule might easily allow the terminal lobule to, apparently, occupy the place of the inner lobule. Such has been the case in this species; but it is not so much the abbreviation of the inner lobule (*C*), though that lobule is certainly degenerate, as the excessive development of the outer lobule (*A*), which has thrown the terminal lobule out of its proper position.

Compared with almost bilaterally-symmetrical, cruciform superior lateral lobes (Pl. LVII, fig. 2; Pl. LXXXI, fig. 9; Pl. LXXXIX, fig. 8; Pl. XCIII, fig. 7), the phylogenetic developmental changes necessary for the evolution of the superior lateral lobe of this species are shown to be very remarkable. Excessive growth of the outer lobule which has partly usurped the functions of the terminal lobule, but has provided for the performance of its own normal duties by throwing out the side shoots a^2, a^3—the consequent proportionate abbreviation of the terminal lobule, coupled with a lateral shifting inwards, this lateral shifting causing coalescence with the inner lobule, whose functions are partly usurped—the usurpation of the functions of the inner lobule causing abbreviation or partial abortion of that lobule,—these are the changes which such a comparison indicates. Such changes have given the lobe a bifid character in the main; and its two portions have been further subdivided into three and two respectively; for the bipartition of *C* is only rudimentary. Thus the lobe is pentadactyloid; and such a shape

[1] The cells parting the terminal and lateral lobules may be called the "interlobular cells."

obviously suggests the name *palmata* for this species, palmate being the botanical term for a leaf of five or more narrow lobes united near the main stalk.[1]

Only one of the *Sonninia* suture-lines figured has any close resemblance to that of the present species. It belongs to a fossil of very distinct shape and ornamentation, namely, *Sonn. obtusiformis* (Pl. LXXII, figs. 3—5); and the likeness is only superficial. A further study of that suture-line, with some new details obtained by further removal of test, is given in the same plate for comparison (Pl. XC, fig. 10). The homologous parts have been lettered to correspond with those of *Sonn. palmata;* and it will be seen that, though both lobes are pentadactyloid, there are important differences between them. In *Sonn. obtusiformis* the lateral lobules, *A* and *C*, are bipartite; and they are more equally arranged each side of the terminal lobule. Thus the lobe may be said to be fairly balanced, although it cannot be described as symmetrical, because the terminal lobule is intra-axial, anisosceloid, and certainly not equicellate. Its inner lobule *C*, though somewhat abbreviated, has compensation in the strong offshoot c^2; but, in *palmata*, *C* is small, and its bipartition is rudimentary. The principal difference, however, is in connection with the outer lobule, *A:* in *obtusiformis* there is no distinct shoot to correspond to a^2 of *palmata;* the shoots apparently correspond only with a^3 and a^1 of this species. Lastly, the outer interlobular cell is very much smaller in *obtusiformis* than in *palmata*. Thus the two superior lateral lobes do not correspond in detail, and their differences may be stated by the following formulæ:

S. palmata—a^3, a^2, a^1, *B*, *C*.

S. obtusiformis—a^3, a^1, *B*, c^1, c^2.

Both of these lobes may conveniently be compared with the papilioniform superior lateral lobe of *S. papilionacea* (Pl. XC, fig. 3), where the formula is—

S. papilionacea—a^2, a^1, *B*, c^1, c^2.

One specimen of the present species was obtained in the summer of 1892, during the excavations at Sherborne in the Sandford-Lane quarry.[2] It came from strata in which *Lioceras concavum* and allies abound, and was about fifteen inches below the "Fossil Bed" (see 'Quart. Journ. Geol. Soc.,' vol. xlix, p. 493, Bed. 11).

This unique and most interesting specimen is figured in Pl. XC—fig. 7, side

[1] Since the above was written Prof. Blake has used the term "palmate" for the lobes of certain *Lytocerata* ("Classif. Ammonites," 'Proc. Geol. Assoc.,' vol. xiii, pt. 2, p. 37), but they are really tridactyloid.

[2] These excavations were undertaken by Mr. Hudleston, F.R.S., and myself to determine the position of the strata to which foreign authors had applied the term "*Sowerbyi*-zone." A paper by myself on the result of these excavations and other investigations in the district was read before the Geological Society, June 7th, 1893 (Abstracts, No. 610). It was entitled "The Bajocian of the Sherborne District: its Relation to Subjacent and Superjacent Deposits."

view reduced one-half; fig. 8, outline of the front view similarly reduced; fig. 9, portion of the suture-line.

Sonninia densicostata, *S. Buckman.* Plate LXXXVIII, figs. 8, 9, 9 *a*.

Discoidal, compressed, hollow-carinate. Whorls ornamented with rather small, well-marked, direct, slightly reclining, ventrally-inclined costæ. (Here and there a rib is bigger than its fellows, and at from 30 mm. up to about 40 mm. diameter some of these ribs carry small knobs. At about 120 mm. diameter the knobs appear again, and the rest of the fossil is ornamented with slightly bullate costæ. A few ribs are connate at the inner margin.) Ventral area subacutely arched, medianly flattened, divided by a well-defined, somewhat large, laterally-compressed hollow carina. Inner margin broad, fairly defined, subconvex, the upper edge much rounded off, especially in inner whorls. Inclusion about one-fourth. Umbilicus concentric, shallow, open, costate, graduate, with gibbous whorls. Whorl-section elliptical.

This species is very different from any other that has been figured in this work, with the sole exception of *Sonn. euromphalica* (Pl. LXXXV, figs. 1—3). Compared with that species, it lacks the central spinous stage, has ribs of more unequal size, and, though comparison is difficult, the outward shelving of the umbilical whorls indicates a more compressed ventral area.

The absence of spines in the inner whorls is a feature of importance. The details of the centre are wanting, but at a radius of about 5 mm. there are plain, slightly-reclining costæ, rather closely set. At a radius of about 13 mm. the costæ become somewhat irregular, and are occasionally connate in pairs on the inner area, the connate pairs parted by one or more single ribs—an ornamentation like that of *biplicata* (see page 345). About half-a-whorl later some of the paired ribs tend to become slightly bullate at their middles. For about another half-whorl every third rib is slightly larger than its fellows, and very slightly bullate—the connate character being obscure, though the ribs are somewhat paired. At about 70 mm radius some ribs become somewhat medianly bullate; and at about 80 mm. radius nearly every rib is furnished with a small elongate knob: in the last ribs this character tends somewhat to decline.

The above details, and others mentioned in the specific diagnosis, separate this species from any of the costate forms, *Sonn. costata*, &c., which agree with it in the absence of spines. There are two foreign species to which it bears more resemblance—*Witchellia Sayni*, Haug[1] [*? Sonninia*] and *Sonn. polyacanthus*

[1] *Ludwigia corrugata*, Douvillé (*non* Sowerby) "Zone *A. Sowerbyi*," 'Bull. Soc. géol. France,'

(Waagen).[1] The former, however, is far less costate, and lacks the bullicostate character. The latter, by possessing this feature, is much closer; but it is much less umbilicate than the specimen before me.

It is advisable to give further details in regard to the comparison of *Sonn. densicostata* and *Sonn. polyacanthus*, in order to prevent misunderstanding. In *Sonn. densicostata* the radius, *minus* carina, is 102 mm.; the umbilicus is 80 mm., and bullicostæ begin at about 70 mm. radius. In Waagen's figure, which is reduced one-half, at the radius $102 \div 2$, the umbilicus is $33 \times 2 = 66$ mm., and knobs[2] are plain at $16 \times 2 = 32$ mm. radius. Further, if what would have been the umbilicus of *Sonn. densicostata* at the same size as Waagen's complete fossil be measured off—and this it is possible to do by following the inner curve (of the lost whorl) as indicated on the test,—the difference in umbilication is still more striking. Waagen's own figures are (page 593 [87])—diameter 264 mm., umbilicus 114 mm.; whereas the umbilicus of *densicostata* at this diameter would have been 135 mm. This want of correspondence in umbilication is the most striking detail, but a comparison of *densicostata* and *polyacanthus* shows many other features of difference.

This specimen of *Sonn. densicostata* is unique. It belongs to the Museum of Practical Geology, Jermyn Street, London; and my thanks are due to Mr. E. T. Newton, F.R.S., for obtaining the loan of it. Its horizon and locality are given as "Inferior Oolite, Beaminster," Dorset. The matrix suggests that it belongs to the *Concavum*-zone, though this surmise requires confirmation. Biologically, its affinities are with *Sonn. polyacanthus;* but it is of an earlier type, as the later time of development of bullicostæ indicates. The suture-line unfortunately is not shown; for the specimen is in too excellent condition, with well-preserved test complete.

SONNINIA SCALPTA, *S. Buckman.* Plate LXXXVII, figs. 1—3.

Discoidal, compressed, carinate. Whorls ornamented at first with small regular spines, then for a space with small plain costæ, to this succeeds a short length of alternate costæ and spinicostæ, which yields to small, closely-set, direct, nearly upright, plain costæ, and these become larger and more distant later in life.

3e série, t. xiii, pl. ii, 1884 (compare especially fig. 1); Haug, "Amm. des Étages moyens," 'Bull. Soc. géol. France,' 3e série, t. xx, p. 308, 1893.

[1] "Zone *Am. Sowerbyi*," 'Geogn.-pal. Beiträge,' Band i, Heft 3, pl. xxix (vi), fig. 1, 1867.

[2] In Waagen's figures the knobs are shown first as round pimples, later as more elongate. The shell, therefore, is first nodicostate, and later bullicostate.

PLATE LXXVII.

Concavum-zone.

Figs. 1, 2.—Sonninia semispinata, *S. Buckman.*

Fig. 1.—Portion of the side view, showing the spines and reclining ribs of the umbilicus. The specimen is nearly wholly septate. Bradford Abbas. My Collection. (Page 343.)

Fig. 2.—Outline of the whorl-section, partly restored, to show the compression.

Figs. 3—5.—Sonninia alternata, *S. Buckman.*

Fig. 3.—Side view of the type-specimen, to show the irregularity of the ribbing. The specimen is nearly wholly septate. Bradford Abbas. From my father's Collection. (Page 346.)

Fig. 4.—Outline of the whorl-section, taken at about one inch from the end of the whorl.

Fig. 5.—The superior lateral lobe.

Figs. 6—9.—Sonninia, sp.

Fig. 6.—Side view of an immature specimen, presumably the young of *Sonninia irregularis*, n. sp. For adult see Pl. XCVIII, and for suture-line of this specimen see Pl. LXXXVIII, fig. 4. This is a nearly wholly septate specimen, and it shows the strong, regular spinous stage changing to the irregular (ribs and spines) stage. Bradford Abbas. My Collection.

Fig. 7.—Front view of the same fossil, showing size of carina and the ventral inclination of the ribs.

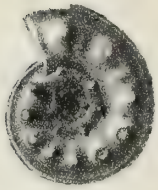
Fig. 8.—Side view of a younger example of the same species. Bradford Abbas. My Collection.

Fig. 9.—Front view of this specimen, showing depressed whorls and carinate, almost bisulcate periphery. (The carina is not quite strong enough.)

Fig 1.

Fig 9.

Fig 8



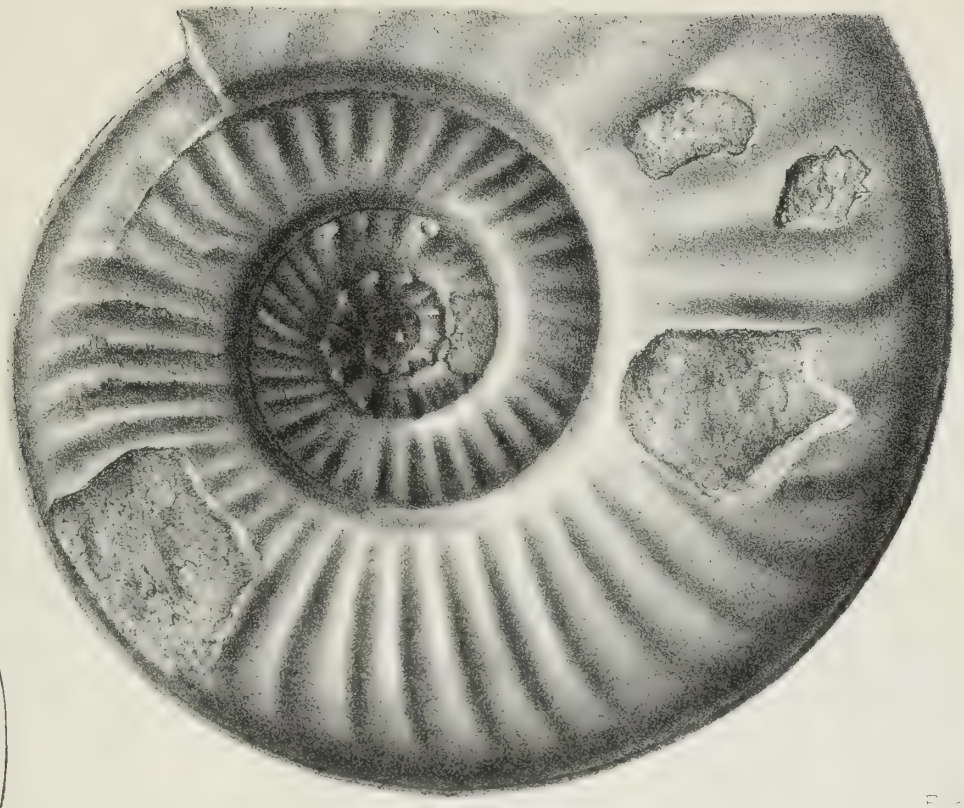


Fig.2

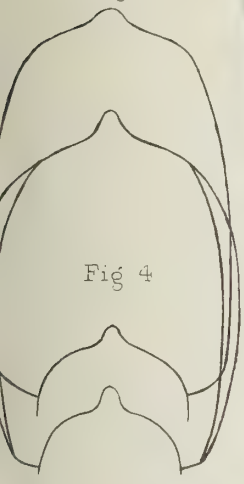
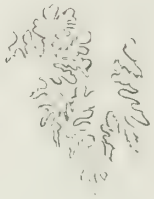


Fig 4



A Gawan del et lith.

PLATE LXXVIII.

Concavum-zone.

Figs. 1—5.—Sonninia biplicata, *S. Buckman.*

Fig. 1.—Side view of the type-specimen, showing the peculiar arrangement of the ribbing—the "biplication" and the "alternation." The test is present, and the specimen is wholly septate. Bradford Abbas. From my father's Collection. (In the front part of the fossil [bottom of plate] the carina is falsified by a layer of test, the remains of the formerly overlapping whorl. The specimen is drawn with this layer *in situ*.) (Page 245.)

Fig. 2.—Outline of the whorl-section, with test. (The inclusion shown is insufficient. The inner margin is not nearly sufficiently pronounced : its inner part is really very steep, though the outer edge is much rounded off. The carina of the embraced whorl has been falsified by lateral layers of test—remains of the inner part of the [formerly] overlapping whorl. This test, which had not become absorbed with that of the preceding whorl, is shown by the dotted lines; and the carina is drawn as it would be if this test were removed.)

Fig. 3.—Suture-line of the same specimen, showing a tetradactyloid superior lateral lobe.

Fig. 4.—Side view of the specimen described in the text as *Sonninia biplicata* β. The specimen is nearly wholly septate. Bradford Abbas. My Collection.

Fig. 5.—Front view of the same fossil.

Fig. 3

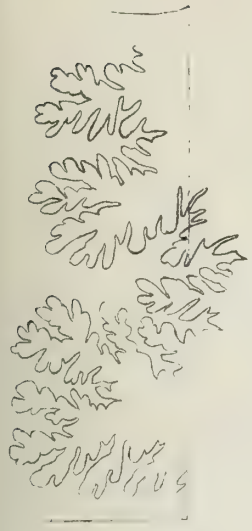


Fig 5

Fig. 4.

Fig 2

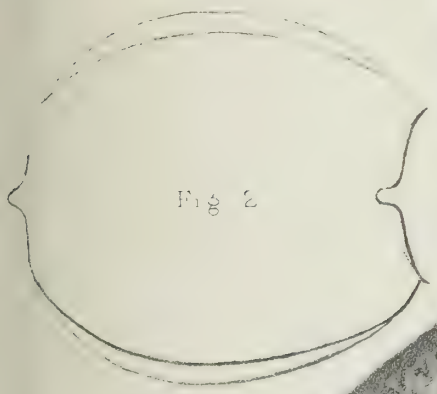
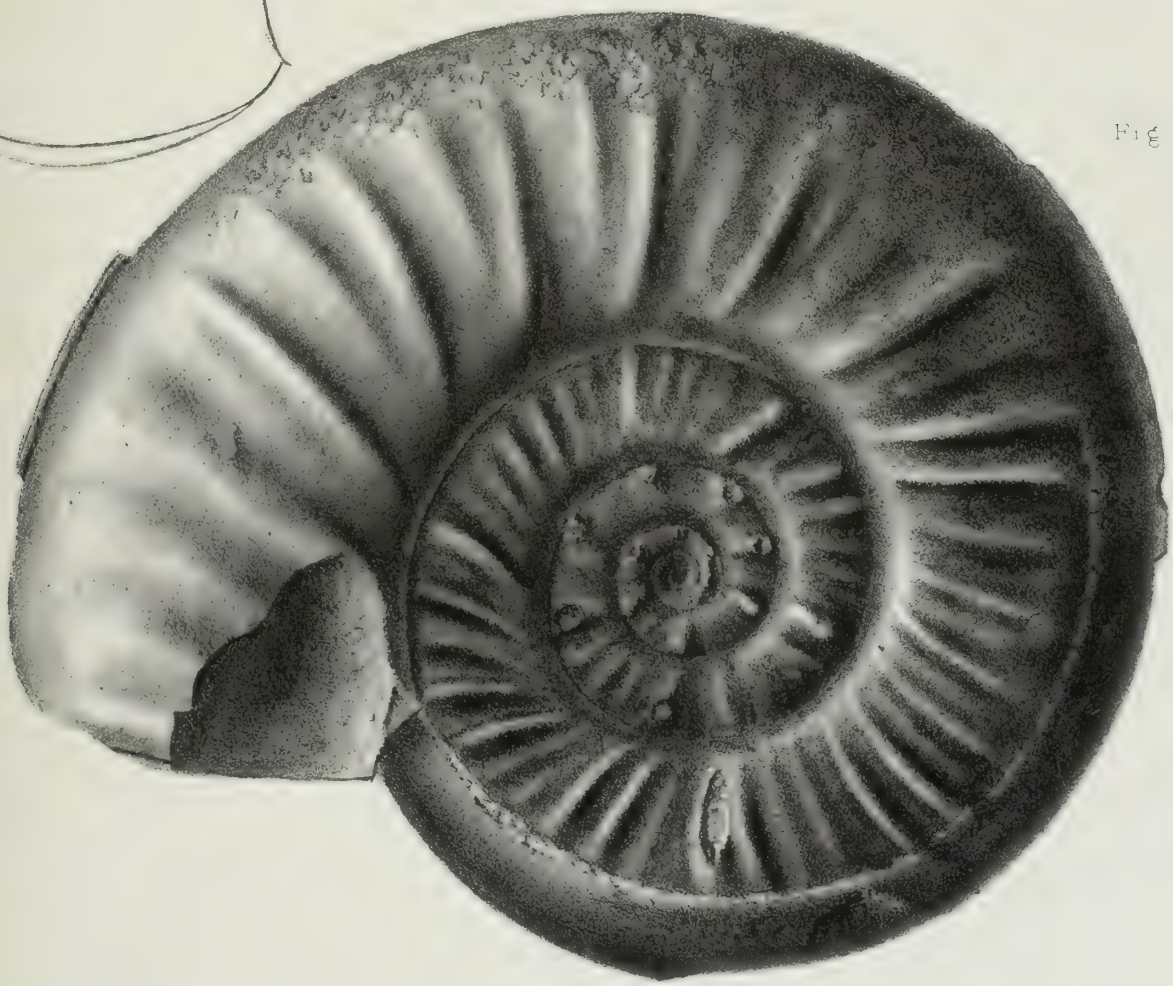


Fig 1



Gawan del. et lith.

Mintern Bros imp.

PLATE LXXIX.

Concavum-zone.

Figs. 1—6.—Sonninia crassiformis, *S. Buckman.*

Fig. 1.—Side view of an immature example, showing the regularity of the large spines. Bradford Abbas. My Collection. (Page 348.)

Fig. 2.—Outline of the whorl-section.

Fig. 3.—Side view of the type—a large adult example—reduced to about one-third of the natural size, the specimen being 290 mm. against 95 mm., the diameter of the figure. (The umbilicus is 124 mm. across.) Bradford Abbas. My Collection.

Fig. 4.—View of the other side of the same fossil similarly reduced. (These two figures are copies from photographs, and they illustrate the difference made by presence and absence of test.) In fig. 3 the ribs of about the first half of the outer whorl have the test preserved, but it is absent from the last portion, and the small size of the last three ribs, with appearance of constriction of the whorl, is noticeable. (At the bottom of the whorl in fig. 3 the ribs are not shown strongly enough.) In fig. 4 the ribs of the outer whorl are without test (the first part is somewhat damaged); but the test is present on the last two ribs as well as on the part of the mouth-border which this figure illustrates. The thickness of the test may be judged from the size of the penultimate rib and the somewhat inflated appearance of the mouth-border,—in fact, in places the test is 5 mm. thick. The body-chamber of this specimen is very short—less than half a whorl.

Fig. 5.—Outline of the whorl-section—one side somewhat restored. Natural size.

Fig. 6.—Suture-line of the same specimen, showing a tetradactyloid superior lateral lobe.

Figs. 7, 8.—Sonninia, sp.

Fig. 7.—Side view of a small shell. Bradford Abbas. My Collection. (Page 349.)

Fig. 8.—Front view of the same specimen.

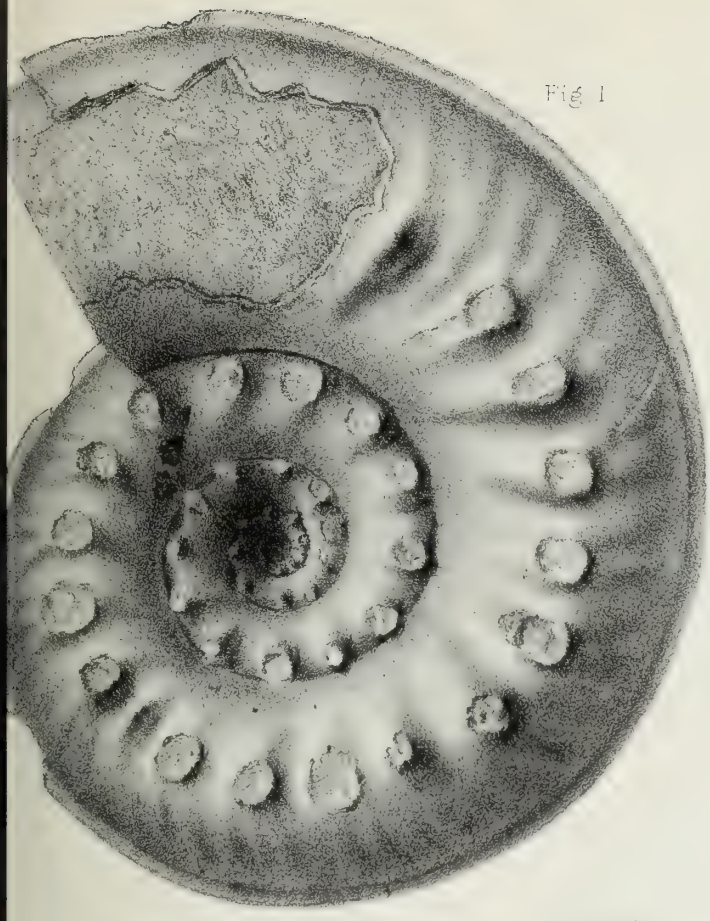


Fig. 1

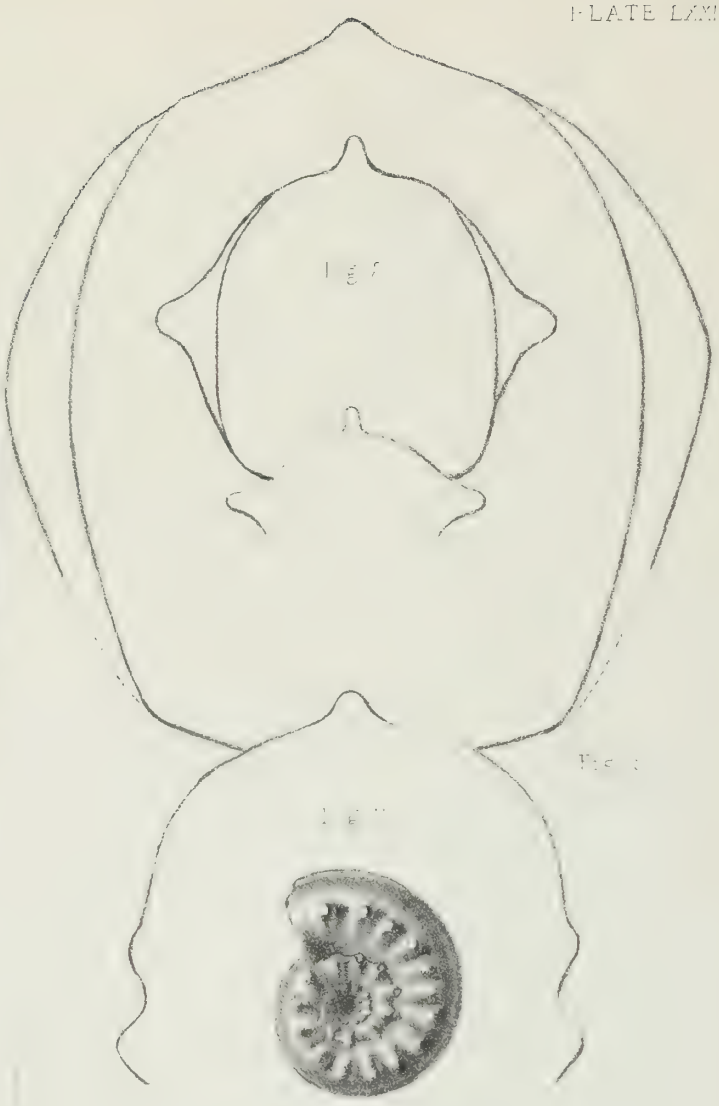


Fig. 2

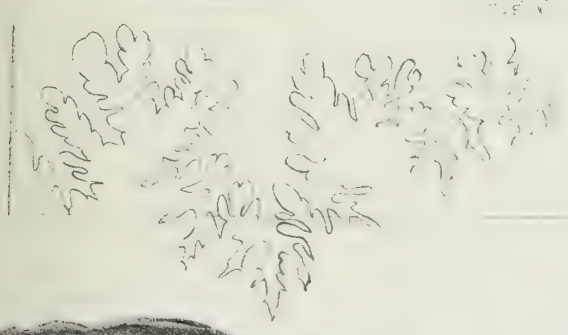


Fig. 4

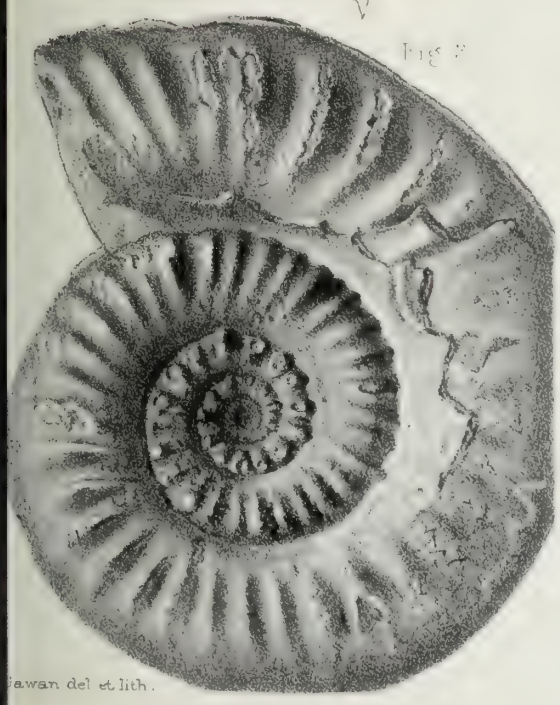


Fig. 7

Fig. 8

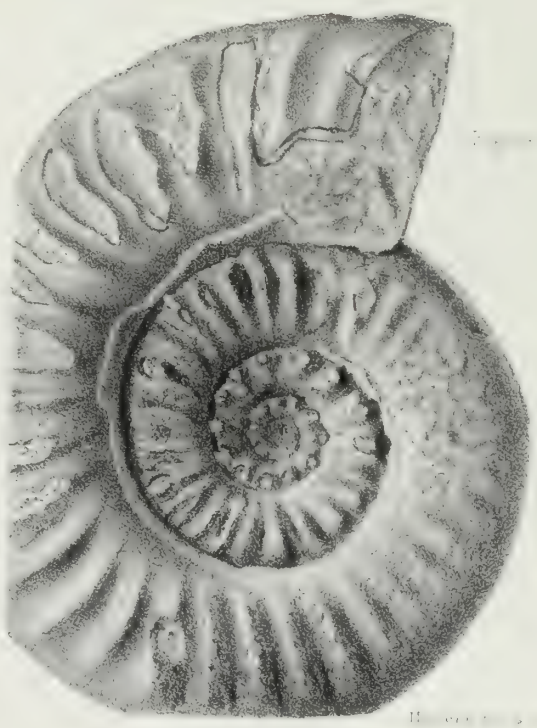


Fig. 9

Sawan del et lith.

PLATE LXXX.

Concavum-zone.

Figs. 1—3.—Sonninia crassibullata, *S. Buckman.*

Fig. 1.—Side view of a grand adult shell with the test preserved. Natural size. The central whorls have been damaged by the chisel, but this damage the artist has not shown. About one-third of the whorl is presumably body-chamber. Bradford Abbas. Formerly in the Collection of Mr. Darell Stephens, F.G.S. Now in my cabinet. (Page 353.)

Fig. 2.—Outline of the whorl-section (with test) of the same specimen.

Fig. 3.—Suture-line from another specimen.

Figs. 4—6.—Sonninia crassicostata, *S. Buckman.*

Fig. 4.—Side view of an immature shell, showing the early appearance of the costate stage. Bradford Abbas. My Collection. (Page 354.)

Fig. 5.—Outline of the whorl-section, with test. The inner edge is rather too sloped.

Fig. 6.—Suture-line from a specimen intermediate between *crassibullata* and *crassicostata.*

Fig 2.

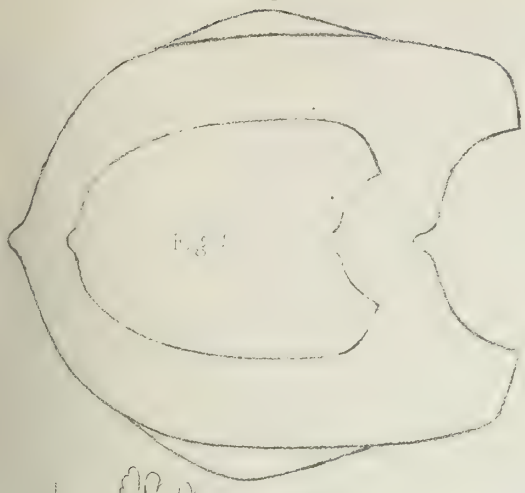


Fig 4

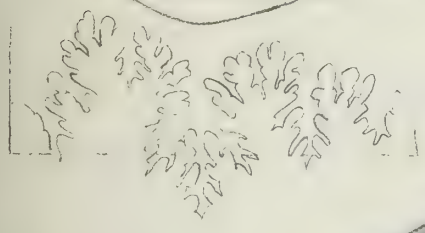


Fig. 6

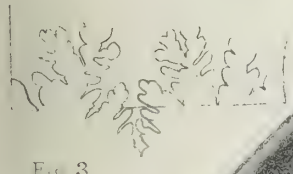


Fig. 3.

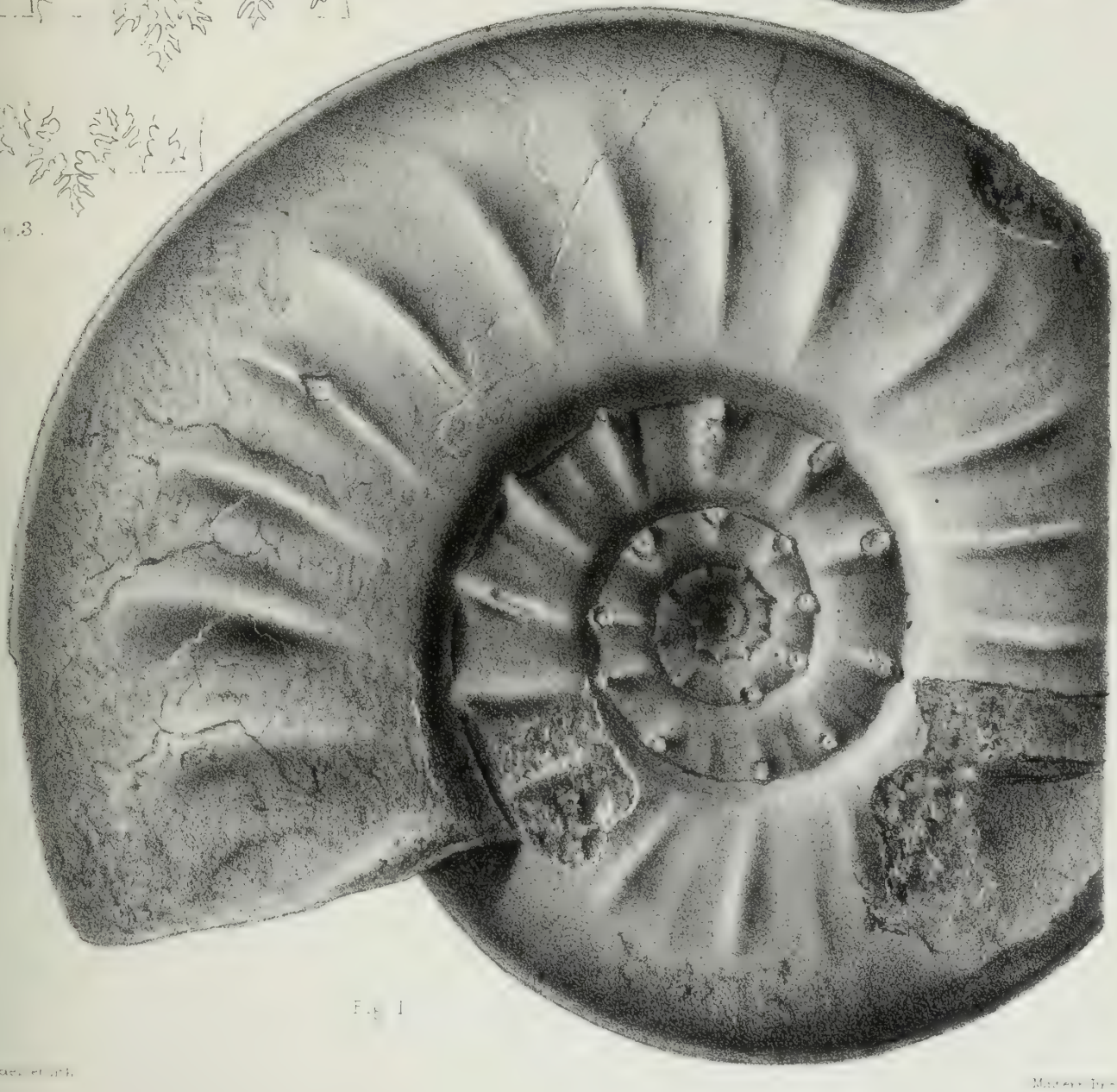


Fig. 1

PLATE LXXXI.

Concavum-zone.

Figs. 1—4.—Sonninia crassinuda, *S. Buckman.*

Fig. 1.—Portion of the side-view of the thick, umbilicate form. Bradford Abbas. (Page 351.)

Fig. 2.—Outline of the whorl-section, with test.

Fig. 3.—Portion of the side-view of the thinner, less umbilicate form. Bradford Abbas. (Page 351.)

Fig. 4.—Outline of the whorl-section, with test. (Both these fossils are immature. They were in the Collection of Mr. Darell Stephens, F.G.S. Now in my cabinet.)

Figs. 5, 6.—Sonninia diversa, *S. Buckman*, var.

Fig. 5.—Portion of the side-view. Bradford Abbas. My Collection. (For the type-form see Pl. LXXXIII, figs. 1, 2.) (Page 355.)

Fig. 6.—Outline of the whorl-section, with test.

Figs. 7—9.—Sonninia spinosa, *S. Buckman.*

Fig. 7.—Side view showing the persistent irregular spinous stage. The specimen possesses the greater part of the test. (The last spinicosta is too arcuate in the drawing.) Bradford Abbas. My Collection. (Page 365.)

Fig. 8.—Outline of the whorl-section without test, but the embraced whorl with test.

Fig. 9.—The suture-line of the same fossil, showing cruciform superior lateral lobe.

(For an idea of the younger stages of this species compare Pl. LXXVII, figs. 6—9. The young shell, figs. 8 and 9, is almost indistinguishable, but is slightly more spinous; the older shell, figs. 6, 7, is, however, more spinous, more costate, and more carinate.)

PLATE LXXXI.

Fig 1

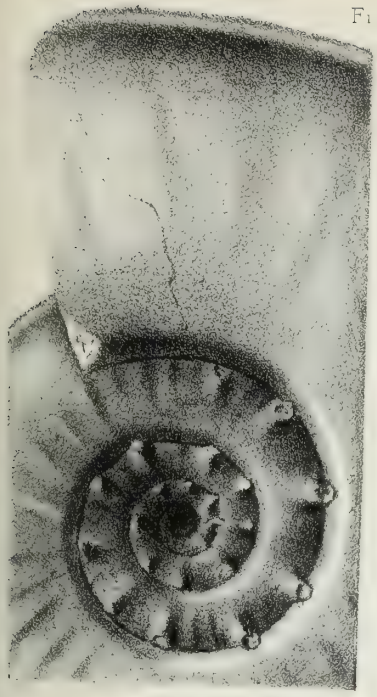


Fig 3

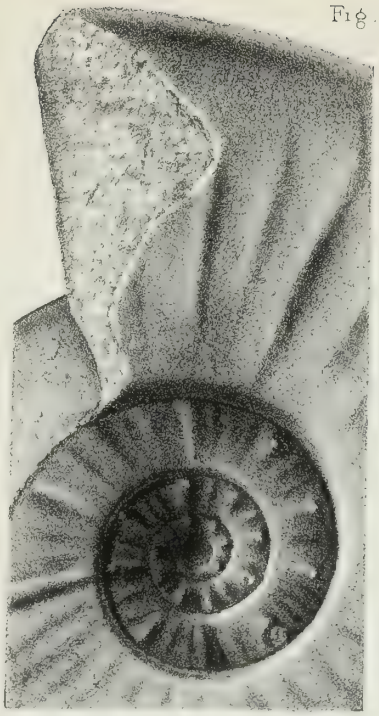


Fig 4

Fig 2

Fig 6

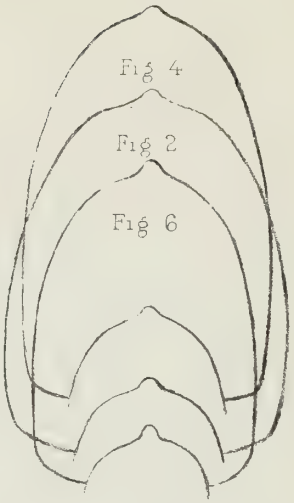


Fig 9

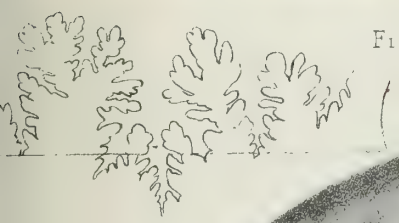
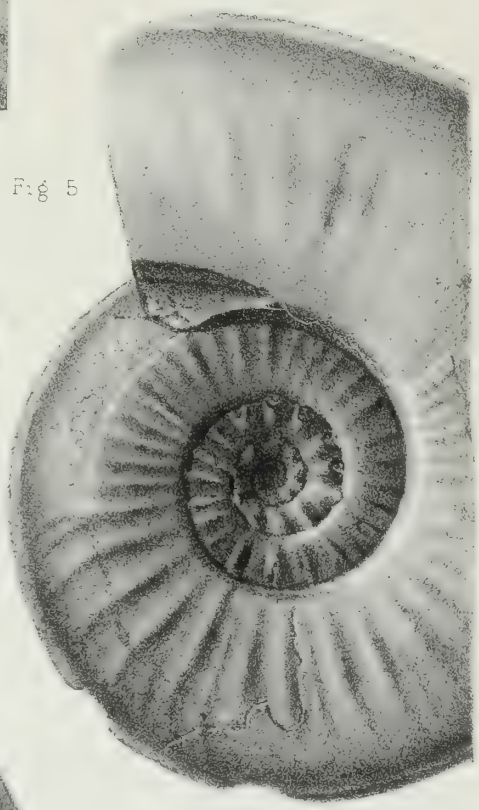


Fig 5



g. 7

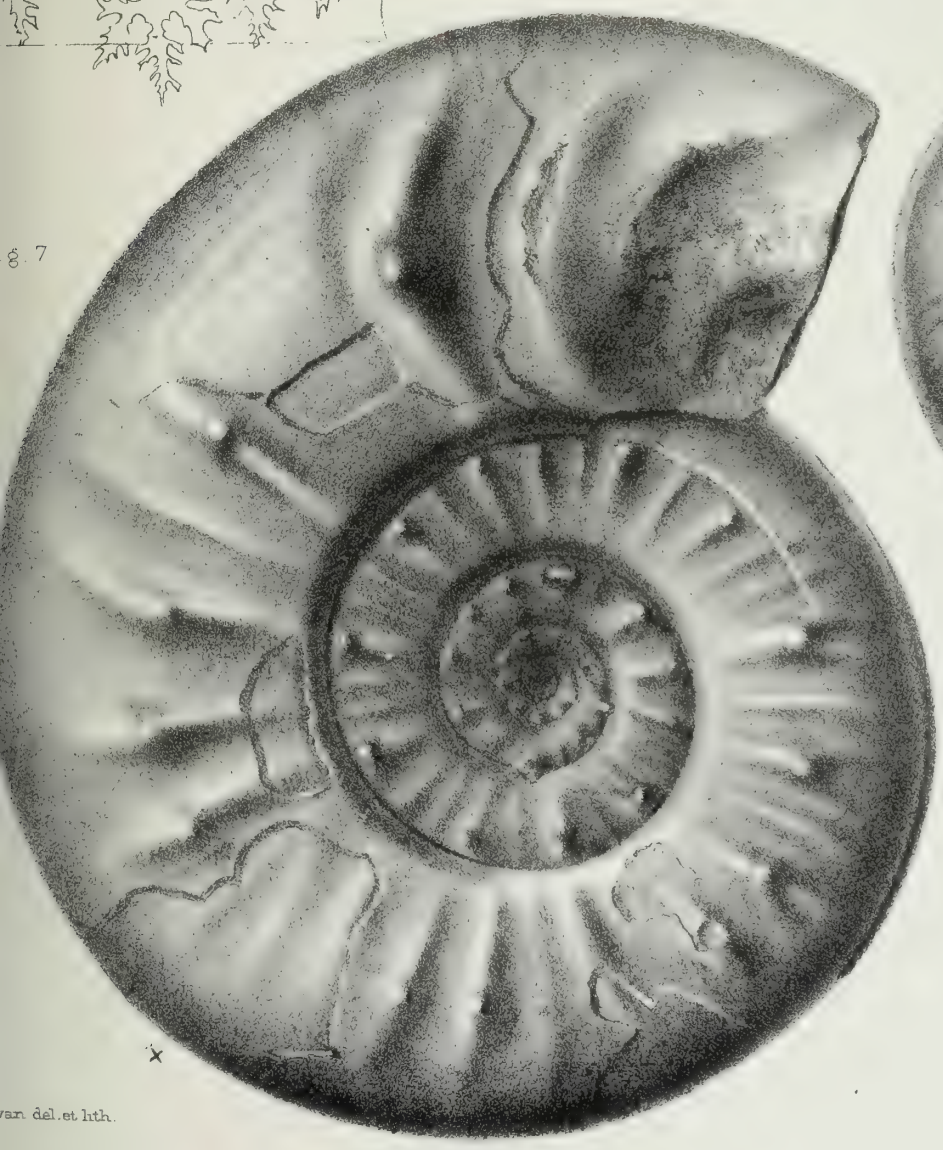
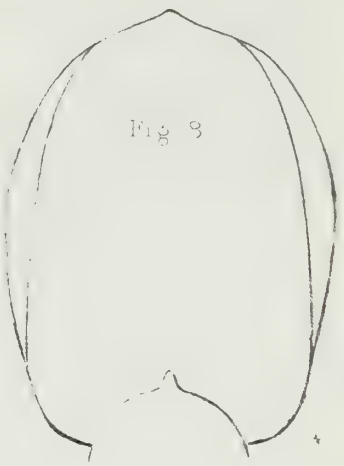


Fig 8



van. del. et lith.

Mintern Bros. imp

PLATE LXXXII.

Concavum-zone.

Figs. 1, 2.—Sonninia crassa, *S. Buckman.*

Fig. 1.—Side view of an adult specimen reduced to two-thirds the natural size. About one-third of whorl is body-chamber. (For this figure it has been necessary to take details from both sides of the specimen.) Bradford Abbas. My Collection. (Page 350.)

Fig. 2.—Restored outline of the whorl-section; with test. Natural size.

Figs. 3, 4.—Sonninia nuda, *S. Buckman.*

Fig. 3.—Portion of the side-view. Bradford Abbas. From my father's Collection. (Page 352.)

Fig. 4.—Restored outline of whorl-section with test, showing outward-shelving whorls.

Figs. 5, 6.—Sonninia lævigata, *S. Buckman.*

Fig. 5.—Portion of side view showing deficiency of central spines. Bradford Abbas. My Collection. (Page 356.)

Fig. 6.—Restored outline of the whorl-section, with test.

Fig. 1

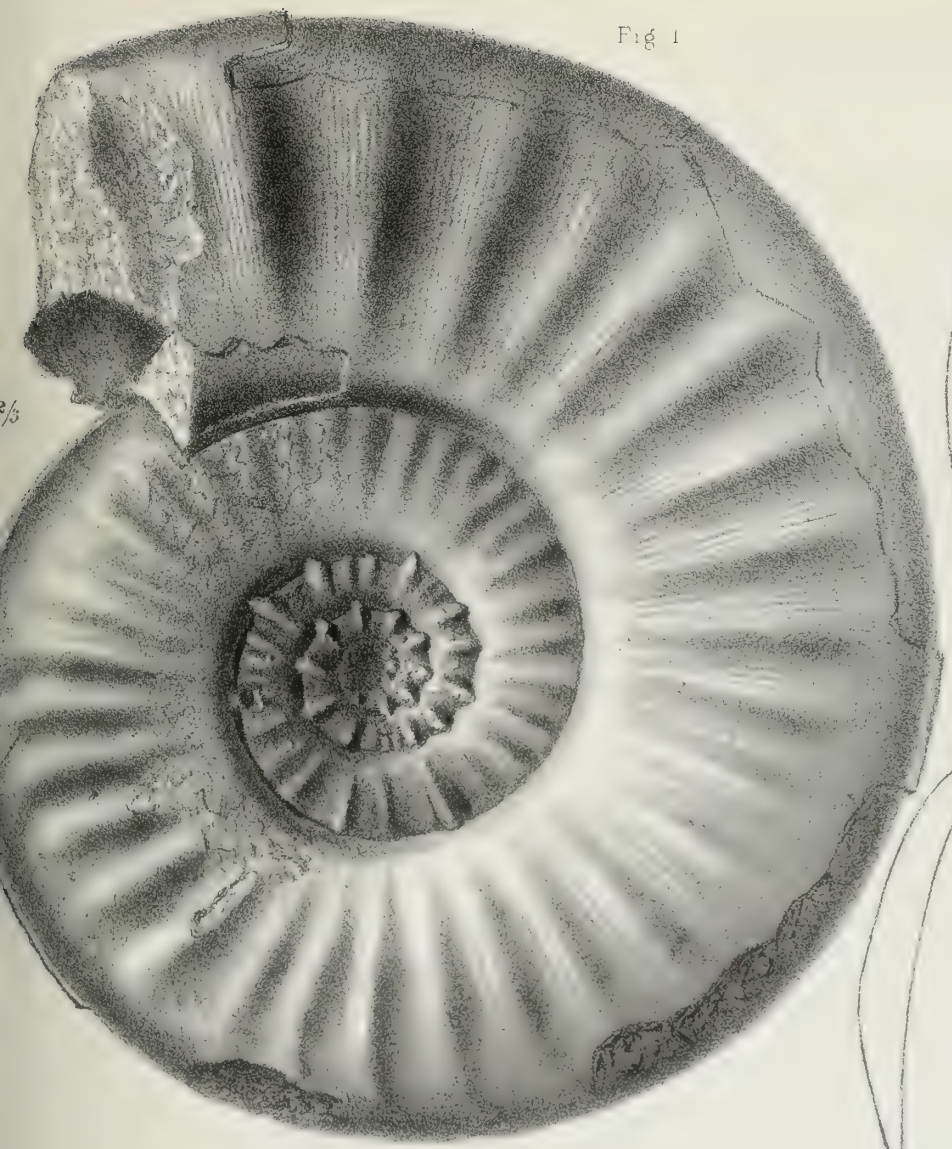


Fig. 4

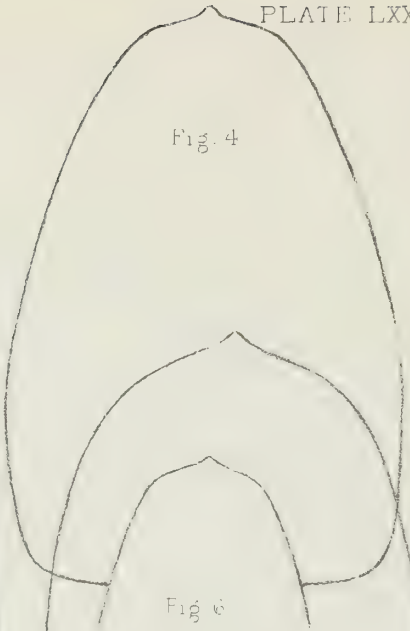


Fig. 6

Fig. 2

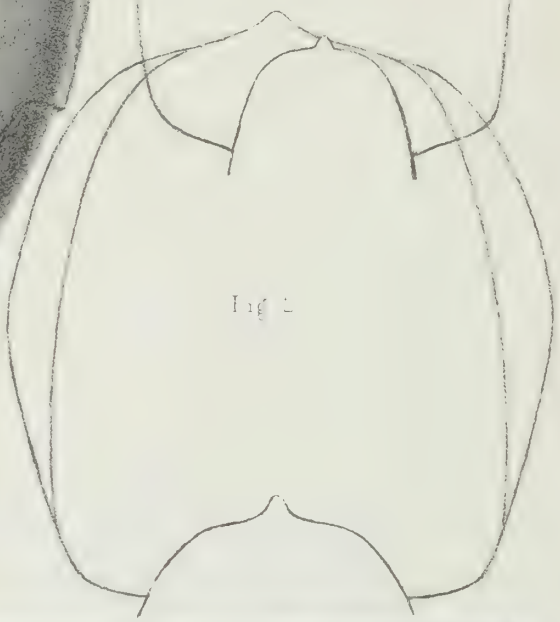


Fig. 5

Fig. 3

. Gawan del et lith.

Mintern Br[illegible]

PLATE LXXXIII.

Concavum-zone.

Figs. 1—4.—Sonninia diversa, *S. Buckman.*

Fig. 1.—Side view of the type-specimen. Bradford Abbas. From my father's Collection. (Page 355.)

Fig. 2.—Front view of the same specimen. (The inner margin is not defined enough; and in Figs. 1 and 2 the carina is rather too large.)

Fig. 3.—Side view of a young example. (The outer whorl is somewhat damaged at the end.) Bradford Abbas. My Collection.

Fig. 4.—Front view.

Figs. 5—9.—Sonninia omphalica, *S. Buckman.*

Fig. 5.—Side view, test present. Inner whorls damaged in cleaning. Bradford Abbas. From my father's Collection. (Page 363.)

Fig. 6.—Front view. The aperture is drawn as it actually is on the specimen: a true section would show it more compressed. (Compare fig. 5.)

Fig. 7.—Suture-line of the same specimen, showing degraded type of septum.

Fig. 8.—Front view of a young example.

Fig. 9.—Side view showing the irregular spinous stage. Bradford Abbas. My Collection.

Fig. 2.

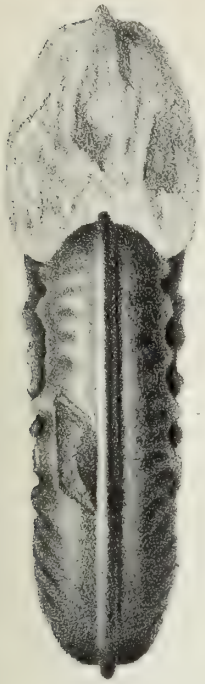


Fig 4.

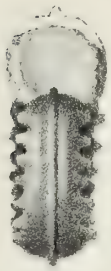


Fig 1

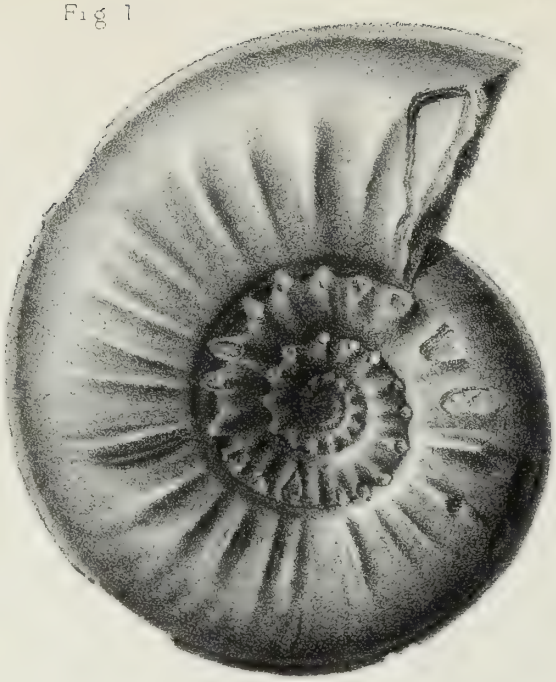


Fig 3

Fig 7

Fig 6

Fig 5

Fig 3

Fig 8

Fig 6

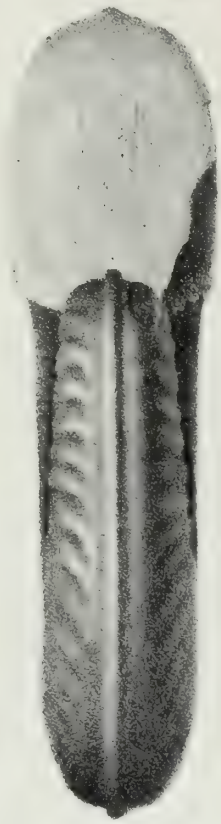


PLATE LXXXIV.

Concavum-zone.

Figs. 1—3.—Sonninia umbilicata, *S. Buckman.*

Fig. 1.—Side view, test present. My Collection.

Fig. 2.—Front view.

Fig. 3.—Suture-line.

Figs. 4—6.—Sonninia subspinosa, *S. Buckman.*

Fig. 4.—Side view of the type-specimen, test present. Formerly in the Collection of Mr. Darell Stephens, F.G.S. Now in my cabinet. (For the young stages of this species see Pl. XLIX, figs. 8, 9.) (Page 358.)

Fig. 5.—Front view. The overlap is not sufficient.

Fig. 6.—Suture-line. The terminal lobule of the superior lateral lobe is intra-axial.

Figs. 7, 8.—Sonninia decorata, *S. Buckman.*

Fig. 7.—Side view, with test. My Collection. (Page 360.)

Fig. 8.—Front view.

Figs. 9—11.—Sonninia subdecorata, *S. Buckman.*

Fig. 9.—Side view, test present. (The connate ribs are shown too conspicuous at their points of origin, which are also too rounded.) My Collection. (Page 361.)

Fig. 10.—Front view.

Fig. 11.—Suture-line from another specimen, showing a superior lateral lobe with the terminal lobule intra-axial and anisosceloid.

Figs. 12—14.—Sonninia decora, *S. Buckman.*

Fig. 12.—Side view, test present. Formerly in the Collection of Mr. Darell Stephens, F.G.S. Now in my cabinet. (Page 361.)

Fig. 13.—Front view.

Fig. 14.—Suture-line, showing a superior lateral lobe with an intra-axial, anisosceloid terminal lobule.

All the specimens in this plate are from Bradford Abbas, and are presumably adult forms.

Fig. 2.

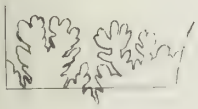


Fig. 4.

Fig. 5.

Fig. 1.

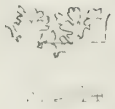


Fig. 12.

Fig. 9.

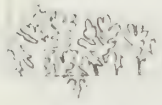


Fig. 11.

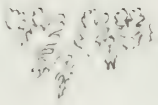


Fig. 7.

Fig. 6.

PLATE LXXXV.

Concavum-zone.

Figs. 1—3.—Sonninia euromphalica, *S. Buckman.*

Fig. 1.—Side view of a specimen with very little test on the outer whorl. Bradford Abbas. From my father's Collection. (Page 362.)

Fig. 2.—Front view.

Fig. 3.—Two septa of the same specimen.

Figs. 4—6.—Sonninia abnormis, *S. Buckman.*

Fig. 4.—Side view of a specimen with most of its test. (The specimen is labelled Bradford Abbas, but the matrix does not quite seem to agree with that of the *Concavum*-zone.) My Collection. (Page 377.)

Fig. 5.—Front view. (The ribs are shown too reclinate, and not sufficiently turned towards the front; but the ventral inclination is not pronounced on this fossil.)

Fig. 6.—Portions of two septa.

Figs. 7, 8.—Sonninia, sp.

Fig. 7.—Side view of a small costate shell, perhaps the young of *Sonninia obtusiformis.* (See Pl. LXXII, and page 333.) Bradford Abbas. My Collection.

Fig. 8.—Front view.

Fig 1.

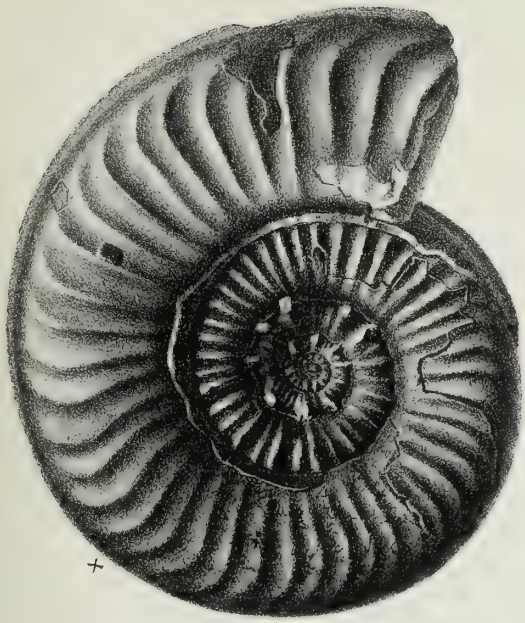


Fig 2

Fig 3

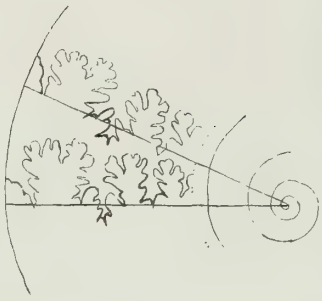


Fig 7

Fig 8

Fig 5

Fig 4

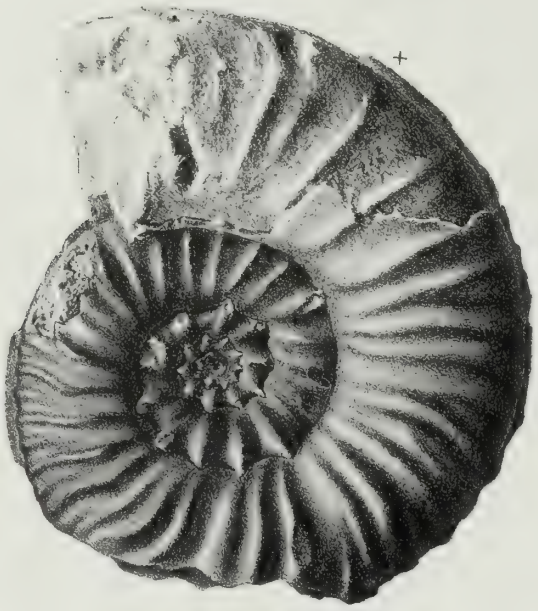


Fig 6

PLATE LXXXVI.

Concavum-zone.

Figs. 1—3.—Sonninia multicostata, *S. Buckman.*

Fig. 1.—Side view of a nearly testate specimen, showing a few spines in the central whorls only. The Railway-cutting, Bradford Abbas. Formerly in the Collection of Mr. Darell Stephens, F.G.S. Now in my cabinet. (The reclination of the ribs on the third quarter of the penultimate whorl is incorrect. The ribs on the whorls make nearly a straight line towards the centre.)

Fig. 2.—Outline of the front view. (The test is wanting on the ventral area of the aperture, but the carina would not be much bigger. The periphery at the bottom of the figure is hardly flattened enough.)

Fig. 3.—Suture-line of the same specimen, showing asymmetrical superior lateral lobe, because of the unequal size of the lateral lobules.

Figs. 4—6.—Sonninia spinea, *S. Buckman.*

Fig. 4.—Side view. Nearly all the costæ of the outer whorl are slightly knobbed. The specimen is wholly septate. Bradford Abbas. My Collection.

Fig. 5.—Outline of the front view. (The test is present on the periphery of the penultimate whorl at the base of the truncate section; it is also present on the periphery of the first half of the ultimate whorl, but the bottom of the figure has been restored so far as the right-hand side is concerned. The test is absent from most of the truncate section, which is drawn as shown by the cast. If the test were present there would be a carina proportionate to that shown on the other parts of the whorl. In the lateral outlines the corrugations of the ribbing have not been shown.)

Fig. 6.—Portions of two consecutive septa, showing a superior lateral lobe with an anisosceloid terminal lobule.

Fig. 2.

Fig 3.

Fig 1

Fig 4

Fig 5

Fig 6

Gewan del. et lith.

Mintern Bros. imp.

PLATE LXXXVII.

Concavum-zone.

Figs. 1—3.—Sonninia scalpta, *S. Buckman.*

Fig. 1.—Side view of a beautifully-preserved specimen, showing spinous stages interrupted by a short costate stage on the latter half of the antepenultimate whorl. Formerly in the Collection of Mr. Darell Stephens, F.G.S. Now in my cabinet. (Page 376.)

Fig. 2.—Front view of the same specimen.

Fig. 3.—Portions of two septa from the same specimen, the one to supplement the other. The lower superior lateral lobe is the best preserved and most trustworthy.

Figs. 4—5.—Sonninia gibbera, *S. Buckman.*

Fig. 4.—Side view of an immature shell with the test preserved. (The central part of the umbilicus is somewhat damaged, but there is indication of a regular strongly-spinous stage.) Bradford Abbas. My Collection.

Fig. 5.—Outline of the front view of the same specimen reduced to two-thirds natural size.

(For septa of this species see next plate.)

Fig 2.

Fig 3

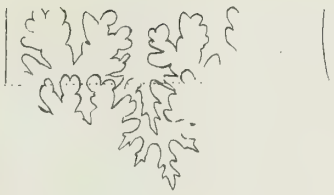


Fig 1.

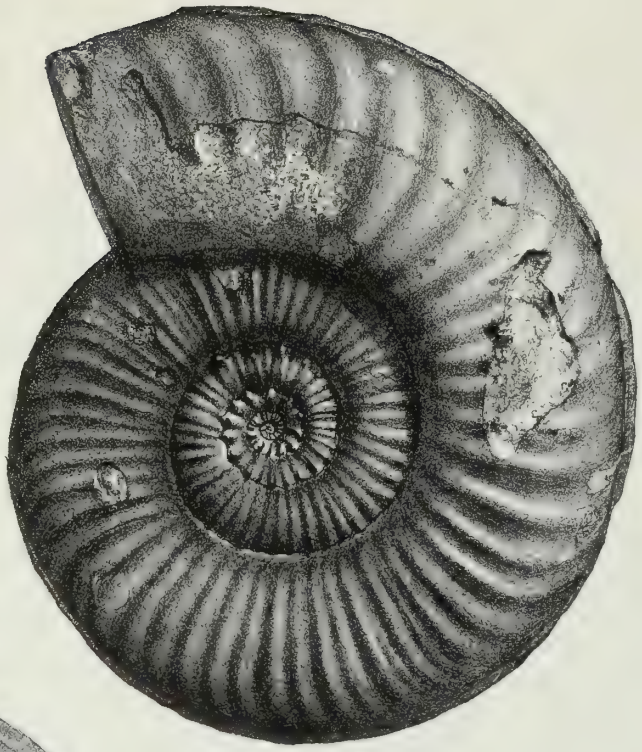
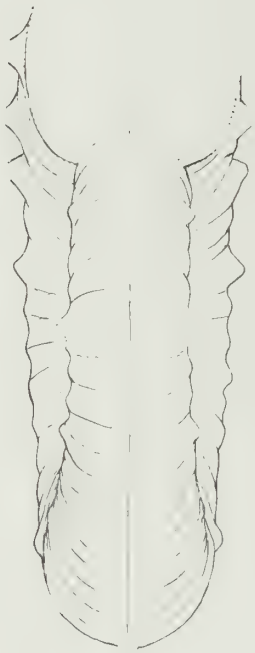


Fig. 4.

Fig 5



F.H Michael del et lith.

Minterm Bros imp.

PLATE LXXXVIII.

Concavum-zone.

Figs. 1—3.—Sonninia gibbera, *S. Buckman.*

Fig. 1.—Portions of two septa of an immature specimen—not the one figured in Pl. LXXXVII—taken at a radius of 61 mm., showing cruciform superior lateral lobes with intra-axial and anisosceloid terminal lobules, but with practically equal-sized lateral lobules.

Fig. 2.—The superior lateral lobe of a larger specimen taken at a radius of 81 mm., showing the same details.

Fig. 3.—Portions of two septa from the same specimen at a radius of 101 mm., showing the same intra-axial, anisosceloid terminal lobule to the superior lateral lobe, but also showing pronounced abbreviation—amounting to abortion—of the inner lateral lobule, and this causes the lobe to be more asymmetrical on account of the unequal size of the lateral lobules, rendering the terminal lobule inequicellate.

(These three figures illustrate the genesis of an asymmetrical, inequipoised lobe. The inner lateral lobule is aborted on account of the approximation of the septa: it really touches the part of the preceding septum which bounds the superior lateral saddle.)

Fig. 4.—Sonninia, sp.

Fig. 4.—Portions of two septa of the specimen depicted in Pl. LXXVII, figs. 6, 7, showing an inequipoised, asymmetrical superior lateral lobe, to compare with fig. 3. These septa are taken at a radius of 44 mm.

Figs. 5—7.—Sonninia contusa, *S. Buckman.*

Fig. 5.—Side view of a presumably adult specimen, reduced to one-half of natural size. The inner whorls are wanting, but on the others the test is present, and the deficiency of ornament is well shown. Bradford Abbas, Dorset. My Collection.

Fig. 6.—Outline of the front view, showing the small size of the carina; test present.

Fig. 7.—Part of the suture-line of the same specimen, showing the superior lateral lobe with inequipoised, short lateral lobules, the inner lobule being abbreviated; the terminal lobule is not quite axial, and is decidedly anisosceloid. A portion of the preceding septum is shown below the inner lateral lobule.

Concavum-zone (presumably).

Figs. 8—9 *a*.—Sonninia densicostata, *S. Buckman.*

Fig. 8.—Side view of a beautiful specimen with well-preserved test, showing numerous closely-set ribs; those of the last three-fourths of the outer whorl with small, very inconspicuous median knobs. The figure is one-half the size of the original specimen, which belongs to the Museum of Practical Geology, Jermyn Street, London. It is labelled "Beaminster [Dorset], No. VIII/$\frac{4}{10}$." (Page 375.)

Fig. 9.—Front view of the same specimen reduced to one-half natural size. (The ventral inclination of the ribs is not shown sufficiently, and the inner margin is not steep enough.)

Fig. 9 *a*.—Outline section of the ventral area, showing the medianly-flattened periphery and the laterally-compressed carina.

Fig. 4.

Fig 2.

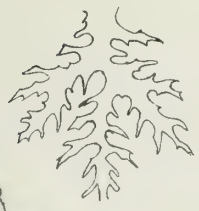


Fig. 3.

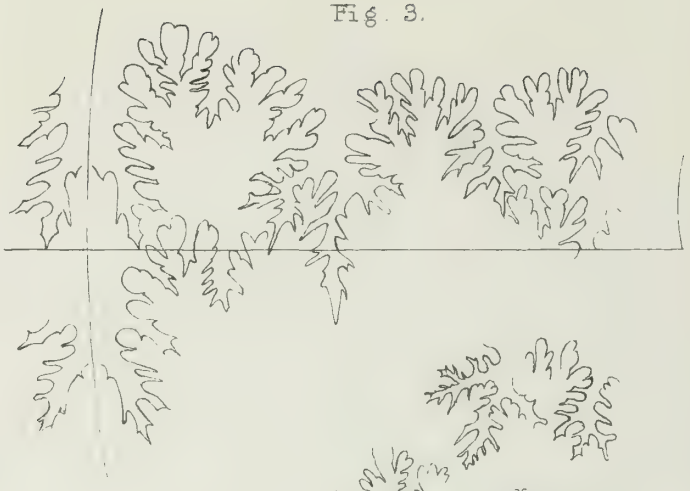


Fig 1.

Fig 8

Fig 7

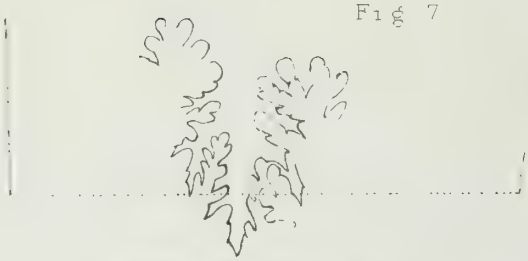


Fig.9a

Fig. 9

Fig 6.

Fig. 5.

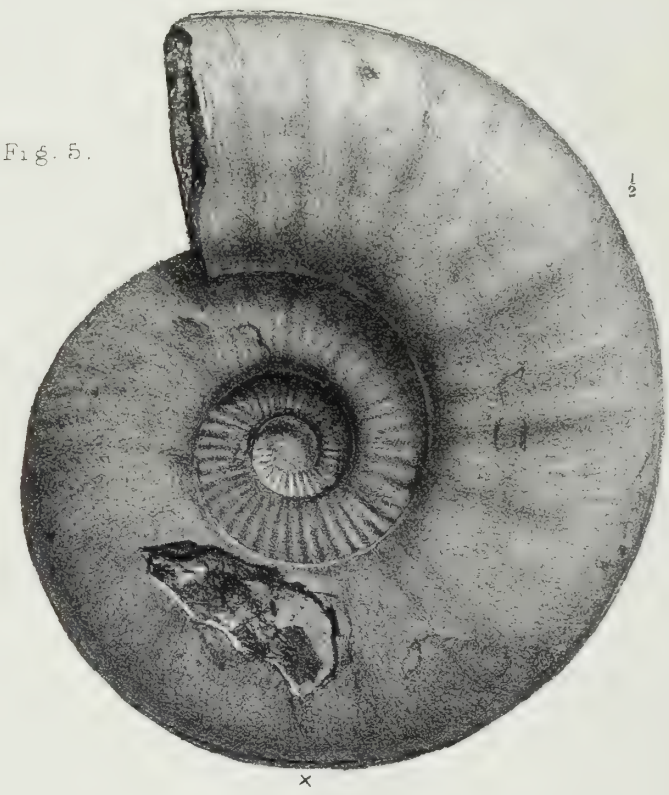


PLATE LXXXIX.

Concavum-zone.

Figs. 1—5.—Sonninia nodata, *S. Buckman.*

Fig. 1.—Side view of a specimen with most of its test preserved. Bradford Abbas. From my father's Collection. (Page 369.)

Fig. 2.—Outline of the front view. The outer edge of the inner margin is too angular.

Fig. 3.—Parts of two septa of the same specimen, showing superior lateral lobe with intra-axial, anisosceloid terminal lobule.

Fig. 4.—Side view of a young form closely agreeing with the inner whorls of the large specimen, but a degree less spinous.

Fig. 5.—Front view of the same specimen.

Figs. 6—8.—Sonninia reformata, *S. Buckman.*

Fig. 6.—Side view of a specimen with test partly preserved, showing spinous stages parted by a costate stage. Bradford Abbas. My Collection.

Fig. 7.—Front view of the same shell. The test is absent from nearly all of the periphery, and the carina is broken away, only the partition-band remaining in places to show that there was a hollow carina. The core is distinctly carinate-bisulcate.

Fig. 8.—Part of the suture-line taken at a radius of 36 mm., showing long and rather elaborate lobes for so small a shell; the superior lateral lobe almost cruciform and symmetrical, the terminal lobule slightly intra-axial and anisosceloid. (The constriction in the middle of the stem of the lobe is exaggerated.)

Figs. 9, 10.—Sonninia, sp.

Fig. 9.—Side view of a small specimen, showing the very early age at which the spinous yields to the costate stage. This is possibly the young form of *Sonn. simplex* (Pl. LXX, page 326), or of its morphological equivalent. It has nothing in common with *S. reformata*, though the plate suggests a false similarity; but the ornament in this form is very decidedly less.

Fig. 10.—Front view.

Fig. C.

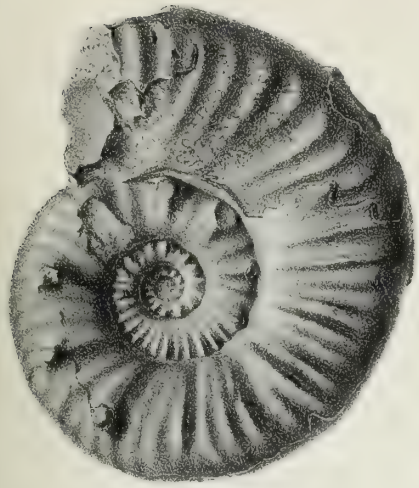


Fig 7

Fig 9

Fig. 2

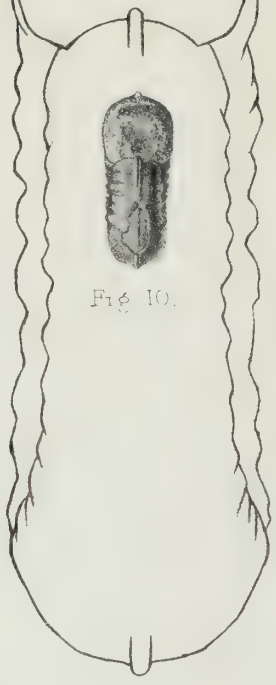


Fig 10.

Fig 8

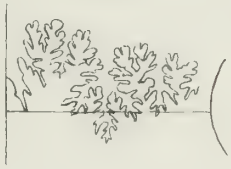


Fig. 1

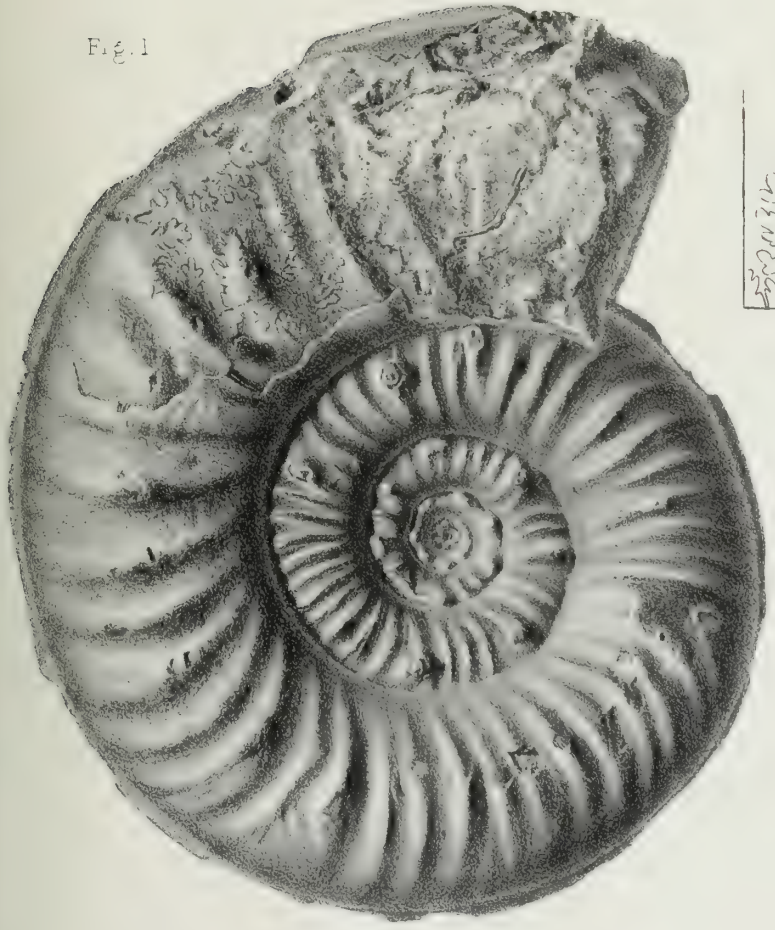


Fig 2

Fig. 5

H. Searle del. et lith.

Mintern Bros. imp.

PLATE XC.

Concavum-zone.

Figs. 1—3.—Sonninia papilionacea, *S. Buckman.*

Fig. 1.—Side view of a specimen with part of the test preserved. Reduced to one-half natural size. Bradford Abbas. From my father's Collection. (Page 367.)

Fig. 2.—Outline of part of the front view. Reduced one-half.

Fig. 3.—Portions of two septa, showing the symmetrical superior lateral lobe with bipartite lateral lobules (papilioniform lobe). Natural size.

Figs. 4—6.—Sonninia attrita, *S. Buckman.*

Fig. 4.—Side view of a specimen with nearly all the test preserved. Reduced to one-half natural size. Bradford Abbas. My Collection. (Page 371.)

Fig. 5.—Outline of the front view. Reduced one-half.

Fig. 6.—The suture-line, showing broad-stemmed, asymmetrical superior lateral lobe. Natural size.

Figs. 7—9.—Sonninia palmata, *S. Buckman.*

Fig. 7.—Side view of a specimen with part of the test preserved; the body-chamber without test. Reduced to one-half natural size. From a bed about fifteen inches below the "Fossil-bed" of Sandford Lane. My Collection. (Page 372.) (The inner whorls to umbilical diameter 20 mm. are badly preserved.)

Fig. 8.—Outline of the front view. Reduced one-half.

Fig. 9.—Part of the suture-line of the same fossil, showing the remarkable pentadactyloid, asymmetrical superior lateral lobe. Natural size.

Fig. 10.—Sonninia obtusiformis, *S. Buckman.*

Fig. 10.—Part of the suture-line redrawn and lettered, for comparison with the suture-line of *Sonn. palmata.* (See Plate LXXII, figs. 3—5.) (Page 374.)

Fig 7

Fig 8

Fig 9.

Fig 10.

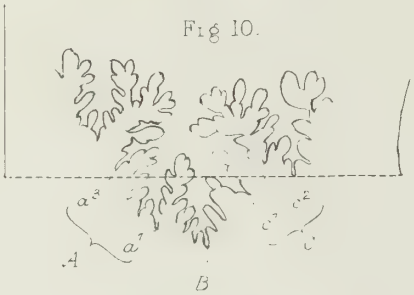


Fig 2.

Fig 3

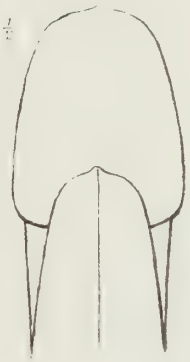


Fig 1

Fig. 4

Fig 5

Fig 6.

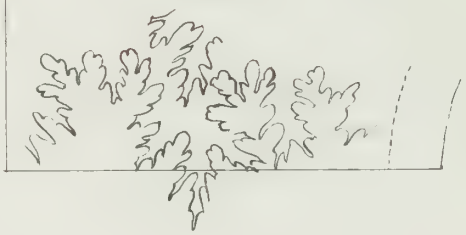


PLATE XCI.

Concavum-zone.

Figs. 1—3.—Sonninia quadrifida, *S. Buckman.*

Fig. 1.—Side view reduced to one-half the natural size. Much of the test is absent from the last whorl. Bradford Abbas, Dorset. My Collection. (Page 366.)

Fig. 1 *a*.—The last part of the outer whorl of the other side, showing the increase in the size of the ribs. In Fig. 1 this is lost, owing to the breakage. Reduced to one-half.

Fig. 2.—Outline of the front view, reduced to one-half (*a*—*a*).

Fig. 3.—Septa showing superior lateral lobe, with isosceloid, axial terminal lobule, and with nearly equipoised, bipartite lateral lobules.

Figs. 4—6.—Sonninia mutans, *S. Buckman.*

Fig. 4.—Side view—reduced to one-half of natural size—showing a spinous stage persistent to the last half-whorl, which is body-chamber. Bradford Abbas. My Collection.

Fig. 5.—Outline of the front view, reduced to one-half (*b*—*b*).

Fig. 6.—Septa showing the superior lateral lobe with anisosceloid terminal lobule.

Figs. 7—9.—Sonninia paucinodata, *S. Buckman.*

Fig. 7.—Side view, reduced to one-half of natural size. Bradford Abbas. My Collection. (Page 370.)

Fig. 8.—Outline of the front view similarly reduced (*c*—*c*). (The inner margin is not sloped enough. It forms with the side an angle of about 120°, and an inner angle 55° with the sagittal line. The indentation is also hardly sufficient, and the ventral convergence is too pronounced.)

Fig. 9.—Septa showing superior lateral lobes with anisosceloid, intra-axial terminal lobules.

Fig. 4.
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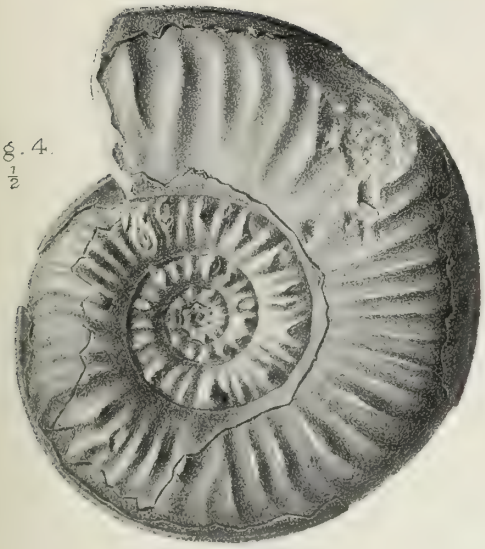

Fig. 3

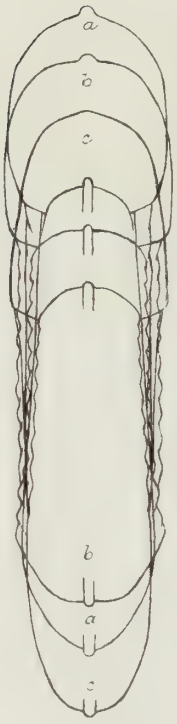

Fig 2
½
Fig 5
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Fig 8.
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Fig 6

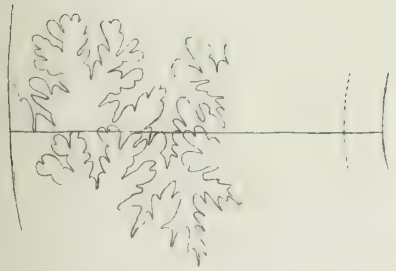

Fig 9.

Fig 1a.

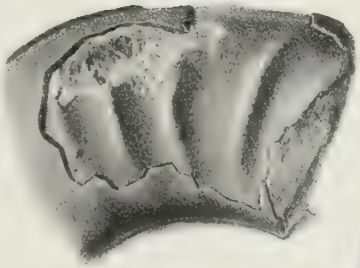

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Fig 7
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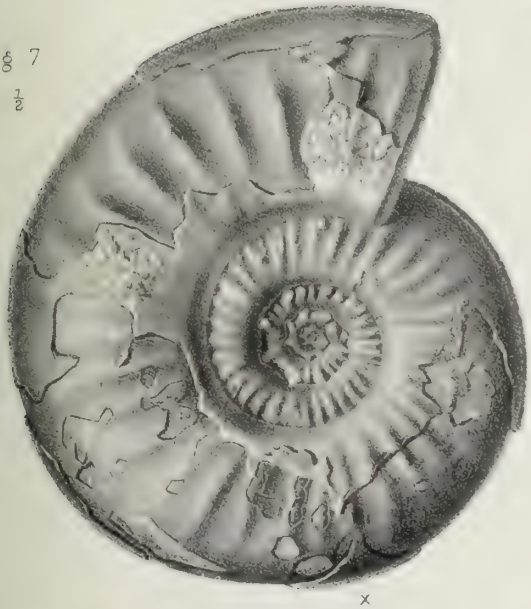

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Fig 1
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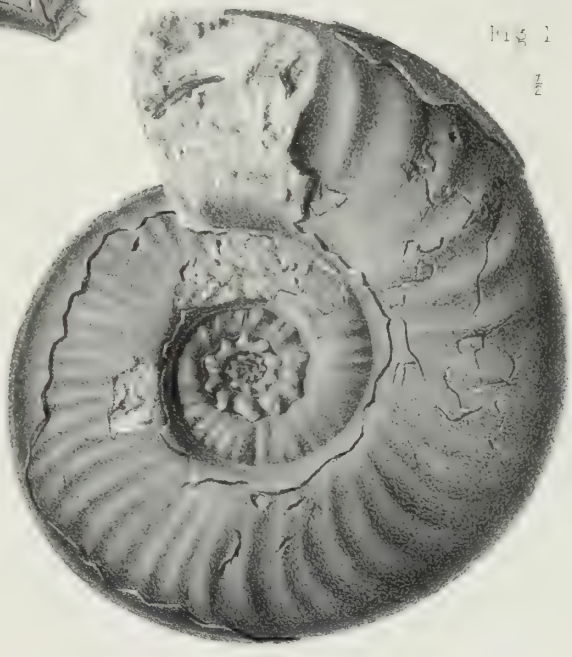

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PLATE XCII.

Concavum-zone.

Figs. 1—4.—Sonninia locuples, *S. Buckman.*

Fig. 1.—Side view of the type-specimen, with the greater portion of the test preserved. Reduced to two-thirds of natural size. (To complete the central part of the umbilicus some details have been taken from the other side.) Bradford Abbas. My Collection.

Fig. 2.—Outline of the whorl-section and part of the embraced whorl, natural size.

Fig. 3.—Portions of two septa of the same specimen (at radius of 100 mm.) showing the extraordinarily long lobes, and a superior lateral lobe with an intra-axial, anisosceloid terminal lobule.

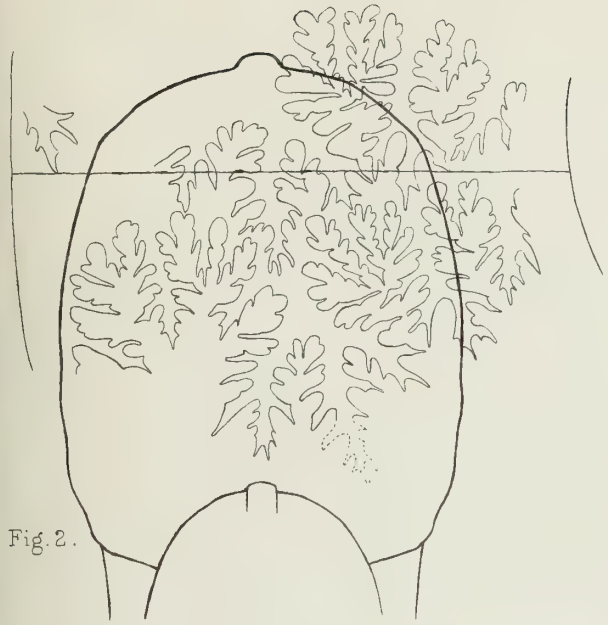
Fig. 4.—Portions of two septa from an immature specimen (at radius of 70 mm.), differing from fig. 3 in having the outer lobule distinctly bipartite. This figure, which shows the approximation of the septa, is for comparison with fig. 2, Pl. LVII, a re-drawing of which, with additional details, is given in Pl. XCIII, fig. 7.

Figs. 5—7.—Sonninia loculosa, *S. Buckman.*

Fig. 5.—Portion of the side view; the central whorls are wanting, and the specimen is poorly preserved generally. Natural size. Bradford Abbas, Dorset. My Collection.

Fig. 6.—Outline of the whorl-section and of part of the embraced whorl. Natural size.

Fig. 7.—Portions of two septa showing very long lobes, the superior lateral lobe with a very long, slightly intra-axial, but isosceloid terminal lobule; the outer lobule bipartite.



g.3.

Fig.2.

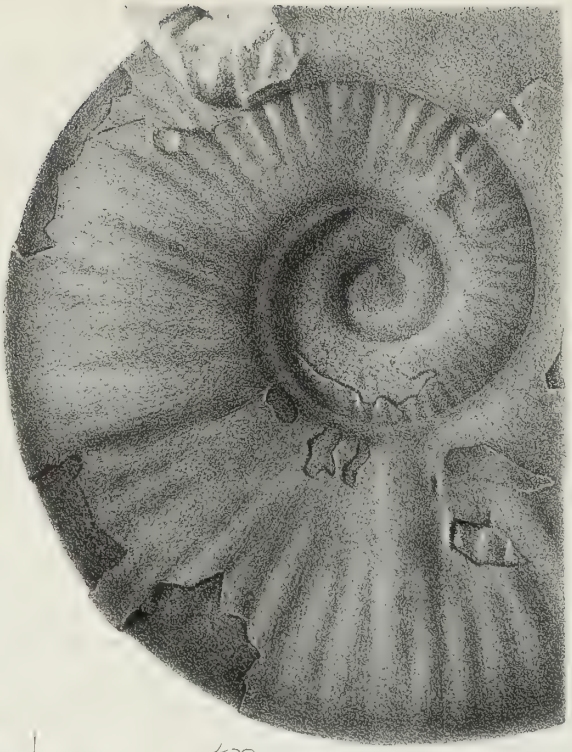


Fig.5.

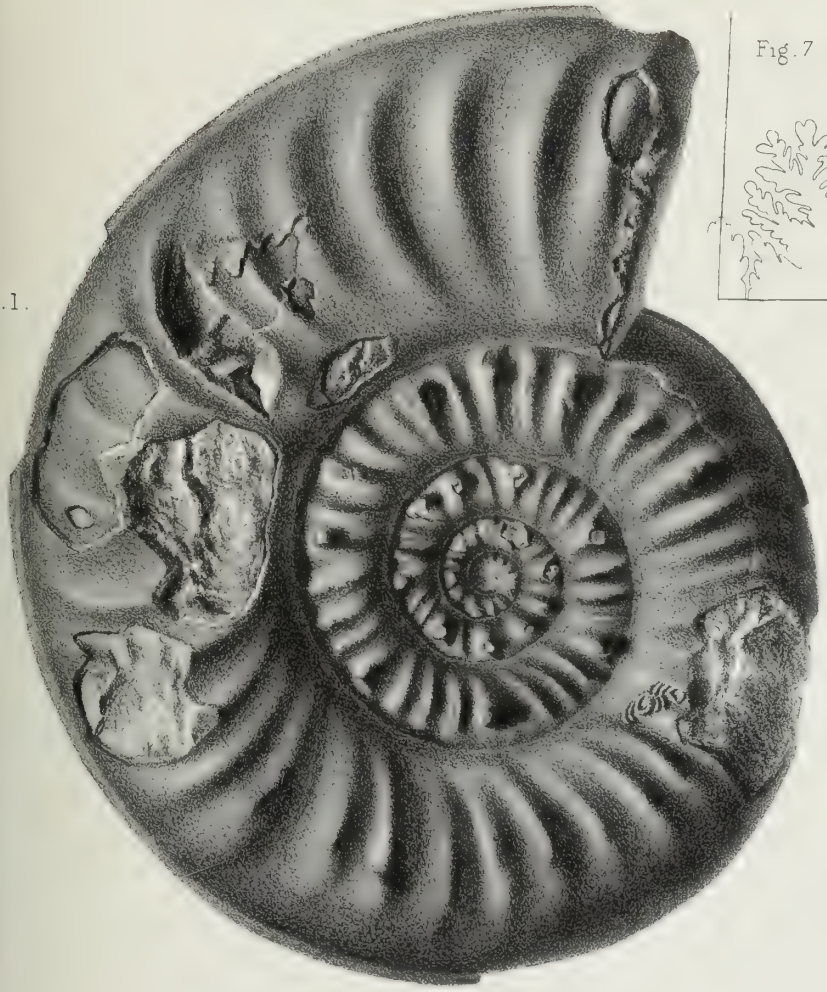


Fig.1.
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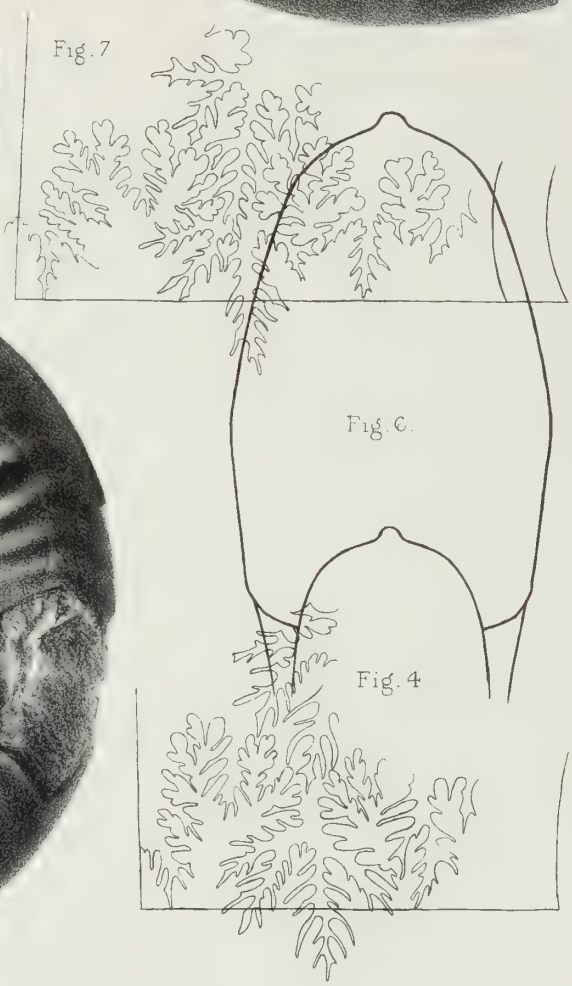

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THE

PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCXLVII.

VOLUME FOR 1893.

LONDON:

MDCCCXCIII.

A MONOGRAPH

OF THE

DEVONIAN FAUNA

OF THE

SOUTH OF ENGLAND.

BY

G. F. WHIDBORNE, M.A., F.G.S.

VOL. II.—PART III.

THE FAUNA OF THE LIMESTONES

OF

LUMMATON, WOLBOROUGH, CHIRCOMBE BRIDGE, AND CHUDLEIGH

(*continued*).

PAGES 89—160; PLATES XI—XVII.

LONDON:

PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.

1893.

PRINTED BY ADLARD AND SON,
BARTHOLOMEW CLOSE, E.C., AND 20, HANOVER SQUARE, W.

Locality.—Two specimens from Lummaton are in my Collection.

Remarks.—This pretty little species is distinguished by its wide and obliquely triangular form, its few and alternating ribs, and its central umbo. Of the accompanying forms it most nearly approaches *Pecten plicatus*, Phillips, ' Pal. Foss.' (not Sowerby), but that shell is distinguished by its much larger and coarser ribs (which seem all equal instead of alternating), by its greater breadth and its less obliquity.

It differs from *Pecten nexilis*, Sowerby,[1] by having much fewer ribs, and much smaller wings, and by being very much more oblique. Sowerby describes the ribs of his species as smooth, but in his figure these appear to be very fine close striæ, which, however, are very much finer and closer than the threads in our specimens.

Pecten Ottonis, Goldfuss,[2] is very similar, but has much more numerous ribs and is less oblique.

Pecten leonis, Semenow and Möller,[3] is less oblique and broader. Its ribs are more prominent on the umbo, and there seems little or no transverse ornament.

P. plicatus, Sowerby,[4] differs widely from it both in shape and in ornament.

2. Crenipecten Oceani, *Goldfuss*, sp. Pl. X, fig. 6.

1834–40.	Pecten Oceani, *Goldfuss*.	Petref. Germ., vol. ii, p. 41, pl. lxxxviii, fig. 10.
1841.	— plicatus, *Phillips* (not *Sowerby*).	Pal. Foss., p. 137, pl. lx, fig. 80ˣ.
1848.	— illegalis ?, *Bronn*.	Handbuch, pt. 3, p. 925.
1848.	— Oceani, *Bronn*.	Ibid., pt. 3, p. 928.
1849.	— — *d'Orbigny*.	Prodrome, vol. i, p. 87.
1853.	— plicatus, *Steininger*.	Geogn. Beschr. Eifel, p. 55.
1854.	Aviculopecten plicatus, *Morris*.	Catal. Brit. Foss., p. 165.
1888.	— — *Etheridge*.	Foss. Brit., vol. i, Pal., p. 159.
1889.	Avicula plicatella, *Whidborne*.	Geol. Mag., dec. 3, vol. vi, p. 78.
1891.	Aviculopecten Oceani, *Frech*.	Abhandl. Geol. Specialk. Preuss., Band ix, pt. 3, p. 20, pl. xvii, fig. 10.

Description.—Shell small, rather flat, nearly equilateral, slightly wider than long. Umbo low, flattened, acute. Hinge-margin unseen. Wings indistinct. Umbo defined by steep, lateral, straight declivities which end in the margin at about one-half the breadth of the shell. Lower part of anterior margin

[1] 1840, Sowerby, ' Geol. Trans.,' ser. 2, vol. v, pt. 3, pl. liii, figs. 1, 2.

[2] 1834–40, Goldfuss, ' Petref. Germ.,' vol. ii, p. 282, pl. clx, fig. 5.

[3] 1863, Semenow and Möller, ' Mél. Phys. et Chim.,' vol. i, p. 703, fig. iv, fig. c.

[4] 1827, Sow., ' Min. Conch.,' vol. vi, p. 144, pl. dlxxiv, fig. 3.

convex. Inferior margin moderately convex. Postero-inferior corner very convex and slightly produced. Contour of back regularly and flatly convex, spreading out to the lower margins. Valves meeting at a very acute angle. Surface bearing about thirty equal rounded ribs, separated by similar furrows, and slightly smaller in the anterior part of the shell, which have the appearance, which is probably deceptive, of being crossed by transverse striæ.

Size.—Length 18 mm., width 18 mm., depth of both valves about 7 mm.

Locality.—A single specimen from Wolborough is in the Museum of Practical Geology.

Remarks.—The specimen here described is that which Phillips figured as *Pecten plicatus*, Sowerby.[1] It is such a worn and indistinct fossil that it is very difficult to decide its true character. It might almost be supposed to be a *Rhynchonella* were it not for the inequilateral character of the ribs, and its close resemblance to some species of *Aviculopecten*. The appearance of wings is very doubtful, and, if remaining at all, they are certainly much injured and confused with matrix. Phillips gives an enlarged portion showing transverse marks, but those in the specimen are really so indistinct that it is more than doubtful whether they are not simply due to fossilisation in a granular matrix.

It appears to differ from *Pecten plicatus*, Sowerby, as given by Phillips,[2] from Yorkshire, by the greater width of the anterior side and by having much fewer ribs. From *Pecten nexilis*, Sowerby,[3] it differs still more in the same particulars. From *P. plicatus*, Sow., as originally described, it differs in the same particulars, and in having the base of the shell much more regularly semicircular, so that I do not think it can possibly be the same species.

On the other hand, it very closely resembles *P. Oceani*, both as originally described by Goldfuss, and as given by Frech. Both figures are rather longer and more oblique, but they both have the appearance of being drawn from shells that might not have preserved their true shape, and they differ as much from each other as they do from the present shell. There would be little doubt of its identity if the two points of the smoothness of the ribs and the existence of wings could be asserted. The former has been already discussed, and Frech speaks of some transverse markings in the German shell. As to the latter point all that can be said is that two projections very like wings exist, but their state of preservation makes it impossible to be certain that they really belong to the fossil. On the whole, the probability is that the English shell belongs to the German species.

Affinities.—From *Crenipecten comma* it certainly differs by its ribs being larger, closer, and not alternating.

[1] 1827, Sowerby, 'Min. Conch.,' vol. vi, p. 144, pl. dlxxiv, fig. 3.

[2] 1836, Phillips, 'Geol. Yorks.,' vol. ii, p. 212, pl. vi, fig. 21.

[3] 1840, Sowerby, 'Geol. Trans.,' ser. 2, vol. v, pt. 3, p. 53, figs. 1, 2.

MOLLUSCOIDEA.

1. Class.—BRACHIOPODA, *Dumèril*, 1806.

1. Order.—ARTICULATA, *Deshayes*, 1836.

In 1882 Dr. Davidson published the Supplement to the 'Monograph on British Devonian Brachiopoda.' In preparing it he used the material in Mr. Vicary's and my own Collection. In it he gave a list of sixty-two species from Lummaton, bringing the total number from the localities at present under notice nearly to seventy.

In 1884 he added another species to the list. Since then comparatively little that is new has come into my hands. I find, however, in many cases specimens which throw some new light on the various species, while there still remain a few species which have hitherto been unrecorded, though in most instances these are represented only by one or two specimens which are not sufficiently perfect to admit of full description. It seems best, therefore, to review these fossils briefly, taking Dr. Davidson's Monograph as a basis, and, except in special cases, only adding references or synonyms from works that have appeared since the publication of his Supplement.

I. *Family.*—Terebratulidæ, *King*, 1846.

1. *Genus.*—Magellania, *Bayle*, 1880.[1]

1. Magellania Whidbornei, *Davidson*, sp. Pl. XI, figs. 1, 1 *a*.

1864. Terebratula sacculus, *Davidson* (pars). Brit. Foss. Brach., vol. iii, pt. 6, p. 6, pl. i, fig. 7, and perhaps others.
1882. Waldheimia Whidbornei, *Davidson*. Ibid., vol. v, pt. i, p. 12, pl. i, figs. 3, 4.
1885. — — *Maurer*. Abhandl. Grossh. Hessisch. Geol. Landes., vol. i, pt. 2, p. 222, pl. ix figs. 15—16 *c*.

Localities.—There are about seven specimens in my Collection, seven in the Woodwardian Museum, and two in the Bristol Museum from Lummaton, and five poor specimens in Mr. Vicary's collection from Wolborough.

[1] Mons. Œhlert points out that *Waldheimia*, King, 1850, must be abandoned, having been before used by Brullé in 1846.

Remarks.—Innumerable specimens of small Terebratuloid shells occur at Lummaton. The preparations of the loop made by Mr. Norman Glass from specimens selected by Mr. Davidson and myself have proved conclusively that these belong to several distinct and in some cases remote species. With this help it has become, in many instances, easy to recognise them by their external characters, but very often, especially in the case of badly preserved or of young specimens, it is still almost impossible to discriminate them with certainty.

Magellania Whidbornei seems to be one of the rarer species. I have found few specimens which seem undoubtedly identical with the shell figured by Davidson as the type of his restricted species, while most of the fossils figured in his earlier work as *Terebratula sacculus* are probably specimens of *C. virgo*, Phillips, sp., or other shells.

Of the shells distinguished by Phillips as *T. sacculus*, *T. virgo*, and *T. hastata*, both the former are probable specimens of *Centronella virgo*, while the latter, which is in the British Museum, is a specimen of *Merista plebeia*.

In outward characters the present species is distinguishable from smooth and worn specimens of *C. virgo* by its blunter, broader beak, its more rounded anterior margin, and its sharper and generally more numerous growth-ridges, which are sometimes seen not only near the margins but over the whole shell. Specimens of *C. virgo* can, moreover, be at once identified if their characteristic arching rows of prominent punctations are well preserved.

Glassia Whidbornei, Davidson, is more difficult to distinguish. It seems a smaller shell, its beak is somewhat narrower, its foramen is higher, and its surface shows no punctations. While, however, full-grown specimens are distinguishable, it seems almost impossible to be certain in the case of younger shells, unless the surface is in a better state of preservation than my specimens usually are.

2. Magellania, ? sp. Pl. XI, figs. 2—2 *b*.

Description.—Shell small, flattish, subpentagonal, elongate. Beak large, high, wide, not much incurved. Area wide, flat, nearly straight. Deltidium large, convex, triangular. Foramen small, circular, immediately under the beak, and very distant from the apex of the dorsal valve. Valves equally convex and meeting at a very small angle. Front margin flat and straight. Surface very minutely and closely punctate, smooth in the centre, and bearing on the marginal third a few very low, rounded, indistinct ribs.

Size.—Length 15 mm., width 12 mm., depth 7 mm.

Localities.—I have one or perhaps two specimens from Lummaton.

Remarks.—This shell gives me some perplexity. It differs from all the other specimens of Terebratuloid shells which I have found in the same localities except *C. virgo* by having low rounded ribs, and possibly by the high position and small size of its foramen. From *C. virgo*, however, it seems to be distinguished by the much greater fineness and irregular arrangement of its puncta, while its foramen seems smaller, higher, and different in shape.

I have only one specimen which definitely shows these characters. It is therefore not safe to give it a name, as it may prove to be an accidental variety of some other shell. A second specimen, which is somewhat similar, is curiously marked with very minute ridges arching inwards, but not quite following the marginal curves.

3. Magellania juvenis, *Sowerby*, sp. Pl. XI, figs. 3, 3 *a*.

1840. Atrypa juvenis, *Sowerby*. Geol. Trans., ser. 2, vol. v, pt. 3, pl. lvi, fig. 8.
? 1855. Terebratula ? inæqualis, *F. A. Römer*. Beitr. Harzgeb., pt. 3, p. 122, pl. xviii, fig. 3.
1864. — juvenis, *Davidson*. Brit. Foss. Brach., vol. iii, pt. 6, p. 8, pl. i, figs. 10—15.
1882. Waldheimia juvenis, *Davidson*. Ibid., vol. v, pt. i, p. 13, pl. i, figs. 1, 2.
? 1884. Terebratula ? inæqualis, *Beushausen*. Abhandl. Geol. Specialk. Preuss., vol. vi, pt. 1, p. 115, pl. vi, figs. 17 *a—c*.
1885. — juvenis, *Maurer*. Abhandl. Grossh. Hessisch. Geol. Landes., vol. i, pt. 2, p. 223, figs. 11, 12 *b*.

Localities.—From Lummaton there are about fifty specimens in my Collection, thirteen in the Woodwardian Museum, eleven in the British Museum, and two in the Bristol Museum. From Wolborough there is a single specimen in Mr. Vicary's Collection, and two in the Museum of Practical Geology.

Size.—One of my specimens considerably exceeds the dimensions given by Davidson, being 19 mm. long, 18 mm. broad, and 8 mm. deep.

Remarks.—It seems to me most probable that *Terebratula ? inæqualis*, F. A. Römer, is only a distorted form of this species. It very nearly resembles one of my specimens.

2. *Genus.*—Terebratula, *Llhwyd*, 1699.

1. Terebratula ? Newtoniensis, *Davidson.*

1864. Terebratula ? Newtoniensis, *Davidson.* Brit. Foss. Brach., vol. iii, pt. 6, p. 8, pl. i, figs. 16, 17.
1882. — — *Davidson.* Ibid., vol. v, pt. i, p. 14, pl. i, fig. 6.
? 1889. Centronella ? imitatrix, *Barrois.* Mém. Soc. Géol. Nord, vol. iii, p. 149, pl. x, figs. 3 *a*, *b*.

Remarks.—This species seems very rare. I have never myself found a specimen at Lummaton. Davidson's latest figured specimen is in the Torquay Museum.

In Mr. Vicary's Collection is a specimen from Wolborough which is smaller and narrower than the original example. It shows that the punctations are extremely minute and crowded. Its front margin is concave, something in the style of *Terebratula quadrifida* of the Inferior Oolite.

3. *Genus.*—Centronella, *Billings*, 1861.

1. Centronella virgo, *Phillips*, sp. Pl. XI, figs. 4—4 *b*.

1841. Terebratula virgo, *Phillips.* Pal. Foss., p. 91, pl. xxxv, fig. 166.
1879. Atrypa Eurydice, *Barrande.* Syst. Sil. Bohèm., vol. v, pl. lxxxv, figs. 2, 1–10 Ét. F.
1882. Centronella virgo, *Davidson.* Brit. Foss. Brach., vol. v, pt. 1, p. 14, pl. i, figs. 8—10.
1885. Atrypa Eurydice, *Maurer.* Abhandl. Grossh. Hessisch. Geol. Landes., vol. i, pt. 2, p. 185, pl. viii, figs. 1—1 *b*.

Size.—The dimensions of two specimens are—length 16 mm., breadth 11 mm., depth 8 mm.; and length 16 mm., breadth 16 mm., depth 8 mm.

Localities.—This is one of the commonest species at Lummaton. There are more than 100 specimens in my Collection, seven in the Bristol Museum, twenty in the Woodwardian Museum, and six in the British Museum, including Phillips's figured type (fig. 166).

From Wolborough there are nine specimens in Mr. Vicary's Collection, two in the Museum of Practical Geology, and five in the British Museum.

Remarks.—*C. virgo* is a very definite though rather variable species, and it is rare that a specimen remains doubtful after examination under a lens. The pentagonal form, the sharp, pinched-in, erect beak, the straight or slightly convex or concave anterior margin, the beautiful arching rows of punctations, and, when present, the numerous low rounded ribs are clear characters; and even in badly preserved shells indications of one or other of them are generally discernible.

The arrangement of the punctations is, unfortunately, not clearly represented in my figures. They form arching radial rows concave to the shoulders of the shell. The low ribs do not seem a very constant character, not being observable in young or in all aged shells.

Some old specimens have a slight sinus on each valve, which causes the anterior margins to be slightly concave, so that the shell sometimes becomes rather cornute: these shells are generally deeper than usual, and do not show any ribs. I am inclined to consider these as the most aged form of the species rather than as a distinct variety.

The majority of the Lummaton specimens have lost their outer surface, and it is only then that the difficulty of determination occurs.

It seems to me probable that Phillips's figured specimen of *T. sacculus* belongs to the same species, and I am inclined to think that several of Davidson's figures in his first Devonian Monograph (*e. g.* pl. i, figs. 2, 3, 5, and 6) really represent specimens of *C. virgo* rather than of *W. Whidbornei*, with which he identifies them in his Supplement.

It appears to me that the German shell identified by Maurer with *Terebratula* (*Atrypa*) *Eurydice*, Barrande, probably belongs to this species. As far as can be judged from his figure and description its external characters agree, and nothing is said of its internal arrangements. Barrande's figures also resemble it.

4. *Genus.*—Meganteris, *Suess*, 1856.

1. Meganteris inornata, *d'Orbigny*, sp. ? Pl. XII, figs. 1—1 *b*.

1847. Atrypa inornata, *d'Orbigny*. Prodrome, p. 92.
? 1855. Meganteris Archiaci, *Suess*. Jahr. Akad. Wissensch., vol. xviii, p. 51, pls. i—iii.
? 1876. — — *F. Römer*. Leth. Pal., pl. xxiii, fig. 6.
1889. — inornata, *Barrois*. Mém. Soc. Géol. Nord, vol. iii, p. 152, pl. x, fig. 5.

Description.—Shell large, transversely oval. Ventral valve convex, especially near the margins. Dorsal valve flattish. Beak small, low, rather incurved, with

rounded sides, truncated by a small foramen which is close to apex of dorsal valve. Muscular impressions very near the beak in ventral valve.

Locality.—A single specimen from Lummaton is in my Collection.

Size.—Length 55 mm., width 65 mm., depth 30 mm.

Remarks.—This shell is distinguished from others that occur at Lummaton by its small overhanging beak with rounded sides, and by the even convexity of its ventral valve. The specimen may perhaps be somewhat crushed, but it appears to differ from all the accompanying shells. From specimens in the British Museum Mr. B. R. Newton and I came to the conclusion that it closely resembled *M. Archiaci*, Suess, but whether it is identical or even congeneric with it is very doubtful.

Barrois, in his 'Fauna Calc. d'Erbray,' gives some good figures of *M. inornata*, which he separates from the true *M. Archiaci*, de Vern.[1] I think his shell probably agrees with ours. In his 'Terrains Anc. Asturias'[2] he had referred to both species under the same name.

M. Archiaci, as given by Schnur,[3] which can hardly, I think, be the same species as the present shell, agrees with de Verneuil's species.

II. *Family.*—Stringocephalidæ, *King*, 1850.

1. *Genus.*—Stringocephalus, *Defrance*, 1827.

1. Stringocephalus Burtini, *Defrance*. Pl. XII, figs. 2, 2 *a*.

1827.	Strygocephalus Burtini,		*Defrance.*	Dic. Sci. Nat., vol. li, p. 102, pl. lxxv, figs. 1, 1*a*.
1864.	Stringocephalus Burtini,		*Davidson.*	Brit. Foss. Brach., vol. iii, pt. 6, p. 11, pl. i, figs. 18—22, and pl. ii, figs. 1—11.
1882.	—	—	*Davidson.*	Ibid., vol. v, pt. 1, p. 19, pl. iii, figs. 2, 3.
1885–9.	—	—	*Maurer.*	Abhandl. Grossh. Hessisch. Geol. Landes., vol. i, pt. 2, p. 221, pl. ix, figs. 13, 14.
1890.	—	—	*Whiteaves.*	Trans. Royal Soc. Canada, vol. viii, sec. 4, p. 93, pl. iv, figs. 1—9.
1891.	—	—	*Whiteaves.*	Contrib. Canad. Palæont., vol. i, pt. 3, p. 235.

[1] 1850, De Verneuil, 'Bull. Soc. Géol. Fr.,' vol. vii, p. 175, pl. iv, fig. 2; 1878, Bayle, 'Expl. Carte Géol. Fr.,' pl. x, figs. 6—9; and 1886, Œhlert, 'Ann. Sci., Géol.,' vol. xix, p. 20, pl. ii, figs 1—8.

[2] 1882, Barrois, 'Mém. Soc. Géol. Nord,' vol. ii, p. 273.

[3] 1854, Schnur, 'Palæontographica,' vol. iii, p. 191, pl. xxvii, figs. 2 *a*—*c*.

Localities.—I have about seventeen specimens from Lummaton, and there are seven in the Woodwardian Museum and one in the Museum of Practical Geology. From Wolborough there are five specimens in Mr. Vicary's Collection, nine in the Museum of Practical Geology, four in the British Museum. From Chircombe Bridge are two specimens in the Museum of Practical Geology.

Remarks.—These specimens are of all sizes. The smallest of mine is much smaller than any of those figured by Davidson. It has an open area, and shows fine undulating rounded striæ or rays on its surface, which are fewer and coarser than those seen in larger specimens. Its ventral valve is also marked by several ridges of growth. Another specimen, which is very little larger, has the area closed and pierced by an oval aperture. The large specimens from Lummaton are for the most part bad, with the surface decoriated and so obscured by matrix, &c., that their identity is frequently doubtful; but it is clear that it is not an uncommon shell at that locality. The size of the beak seems very variable.

Maurer mentions a species of Barrande's[1] from Bohemia distinguishable by its narrow hinge-line. One of the specimens, however, in the Museum of Practical Geology, figured by Davidson has its area exceedingly small.

2. *Genus.*—Enantiosphen,[2] nov. gen.

This genus can be only provisionally suggested, as its internal arrangements are very imperfectly known. A strong median septum in the ventral valve, bearing oblique dental processes, distinguishes it, as Mons. Œhlert points out, from *Meganteris*, which in many external characters it resembles. The small elevated beak with sharp beak-ridges, the minute apical foramen, the flattened geniculated valves, and the unpunctured surface are other characteristics, but its true affinities remain to be ascertained.

1. Enantiosphen Vicaryi, *Davidson*, sp. Pl. XI, figs. 5—8.

1864. "Species undetermined," *Davidson*. Brit. Foss. Brach., vol. iii, pt. 6, pl. xx, figs. 15—15 *b*.

1882. Meganteris? Vicaryi, *Davidson*. Ibid., vol. v, pt. 1, p. 20, pl. iii, figs. 1—1 *b*.

Localities.—Besides the specimens enumerated by Davidson I have eight from Lummaton in my Collection. There are two from Wolborough in Mr. Vicary's Collection, and one from Lummaton in the British Museum.

[1] 1879, Barrande, 'Syst. Sil. Bohêm.,' vol. v, pl. lxxxiii, figs. 6 *a—f*, Ét. F.

[2] From *ἐναντίος*, reversed; and *σφήν*, a wedge.

Remarks.—My specimens enable me to add something to the description given by Davidson.

The foramen is minute and situate at the extreme apical point. Davidson states that it is concealed by the incurvature of the beak over it; this incurvature is not shown in my specimens, and therefore must have been extremely slight, or due to accident. On the other hand, the deltidium appears to have been large.

The ventral valve bears a large thin median septum extending at least one-half down the shell, to which two large oblique dental plates converge. This is much like the arrangement in *Pentamerus* or *Merista*, but it evidently belongs to neither of these two genera, and I have not yet been able to find a true resting-place for it. In the dorsal valve there is also a thin median line extending more than halfway down; fragments of the shell being removed in two specimens show that this median line is, at least near the hinge-line, not a single septum, but the junction of two meeting at a small angle.

The surface of the shell is smooth and dense without punctations, but with a few very minute, transverse, angular elevations. When the external surface is gone the structure of the shell takes the form of diverging radiating angular rods, which leave their mark on the cast.

The peculiar marginal inward curve or " wide, flattened, bi-concave border " is not always seen. While this is greatly developed in most specimens, both large and small, three of my specimens show no signs of it, but their valves are regularly curved throughout, and meet at a very small angle. I am in some doubt whether these unthickened specimens ought not to be regarded as distinct, though it appears probable that they may be only immature though large examples. Mons. Œhlert considers them as separable, and if so I would propose for them the provisional name of *E. Œhlertii* (Pl. XI, figs. 8, 8 *a*, 8 *b*).

The shell varies very greatly in transverseness, as the following measurements of two of my specimens show :—Length 40 mm., width 35 mm., depth 25 mm.; length about 53 mm., width 77 mm., depth 38 mm.

III. *Family.*—Spiriferidæ, *King*, 1846.

1. *Genus.*—Merista, *Suess*, 1857.

1. Merista plebeia, *Sowerby*. Pl. XII, figs. 3—6.

1840. Atrypa plebeia, *Sowerby*. Geol. Trans., ser. 2, vol. v, pt. 3, pl. lvi, figs. 12, 13.

1864. Merista plebeia, *Davidson*. Brit. Foss. Brach., vol. iii, pt. 6, p. 20, pl. iii, figs. 2—10.

1882. MERISTA PLEBEIA, *Davidson*. Brit. Foss. Brach., vol. v, pt. 1, p. 20, pl. i, figs. 26—29.

1885. — PRUNULUM, *Maurer*. Abhandl. Grossh. Hessisch. Geol. Landes., vol. i, pt. 2, p. 167, pl. vii, figs. 11, 12.

1886. — PLEBEIA, *Œhlert*. Ann. Sci. Géol., vol. xix, p. 25, pl. ii, figs. 25—27.

Size.—The variation in dimensions is still greater than that given by Davidson. Two specimens measure—in length 13 mm., width 15 mm., and depth 7 mm.; in length 14 mm., width 10 mm., and depth 7 mm.

Localities.—From Lummaton there are very many specimens in my Collection, twenty in the Woodwardian Museum, three in the Torquay Museum. From Barton there are twenty specimens in the Lee Collection of the British Museum, including one which was figured by Phillips as *Terebratula hastata;* one in the Museum of Practical Geology, one in the Bristol Museum. From Wolborough there are four specimens in Mr. Vicary's Collection, eight in the Museum of Practical Geology, and one in the British Museum. From Ramsleigh there is a specimen in Mr. Vicary's Collection.

Remarks.—The numerous specimens sent to Mr. Glass yielded to him less information about the interior arrangements than was expected, but since then I have collected some naturally fractured specimens which add a few interesting particulars.

First, as to the ventral valve, it appears that the shoe-lifter process supported on the interior two large oblique dental plates.

Secondly, as to the dorsal valve, some weathered specimens show on the surface an arrow-headed mark ⍲ of which the stem is rather longer than the barbs. Other natural sections show that this central line or stem is the edge of a perpendicular septum of some depth; while in another specimen the portions of shell lying between this edge and the two barbs have fallen out, leaving two adjacent shallow concave triangular hollows. Thus it appears that in the dorsal valve there is a process corresponding to the shoe-lifter process, but consisting of a double instead of a single fold.

The variation in shape of this species is considerable; sometimes the beak is much, sometimes comparatively little incurved. It varies also in the loftiness of the beak, the expansion of the sides, the depth of the fold, and the distance of the greatest transverse diameter from the beak. The fold generally forms a broad simple curve, flattened in the centre, but, in a few specimens belonging to the shape or variety described by Sowerby as *A. lacryma*, it is sinuated by a central depression. Of this latter shape there is one specimen in my Collection and one in the British Museum from "Torquay," while in the Museum of the Geological Society are Sowerby's original types. From the existence of intermediate forms

connecting it with the typical shape of *M. plebeia* there may be reason to think that Davidson is right in uniting it with this species, but its spheroidal shape is certainly remarkable. Mons. Œhlert is inclined to regard it as distinct.

M. plebeia is frequently marked with coarse growth-ridges.

It appears to me that Kayser has reason for uniting *M. prunulum*, Schnur, with Sowerby's species; and that Maurer's version of that shell is only a somewhat elongated variety, which is very similar to some English specimens of it.

Meristella Circe, Barrande,[1] as given by Barrois,[2] looks exactly like our shell, but he intimates that it differs generically, being without the shoe-lifter process.

Merista passer, *vultur*, and *Calypso*, Barrande,[3] all closely resemble different specimens of the English shell, and I think they are only larger varieties of it.

2. *Genus.*—Athyris, *McCoy*, 1841.

1. Athyris Glassii, *Davidson.*

1882.	Athyris Glassii,	*Davidson.*	Brit. Foss. Brach., vol. v, pt. 1, p. 24, pl. i, figs. 21, 22.
1885.	—	—	*Maurer.*	Abhandl. Grossh. Hessisch. Geol. Landes. vol. i, pt. 2, p. 164, pl. vii, figs. 7—7 *c*.

Size.—Length, 14 mm.; breadth, 13 mm.; depth, 7 mm.

Localities.—From Lummaton are seven specimens in my Collection, and from Wolborough three in Mr. Vicary's Collection.

Remarks.—This species seems recognised by its flattish transverse shape, sharp uncurved beak, and smooth surface.

2. Athyris concentrica, *Von Buch.*

1831.	Terebratula concentrica,	*von Buch.*	Abhandl. Konigl. Acad. Wissen. Berlin, p. 103.
1864.	Athyris concentrica,	*Davidson.*	Brit. Foss. Brach., vol. iii, pt. 6, p. 14, pl. iii, figs. 11—15, 24.
1868.	Spirigera concentrica,	*Dames.*	Zeitsch. Deutsch. Geol. Gesell., p. 496, pl. x, figs. 6, 7.
1882.	Athyris concentrica,	*Davidson.*	Brit. Foss. Brach., vol. v, pt. 1, p. 25, pl. i, figs. 23, 24; and pl. ii, figs. 10, 10 *a*.

[1] 1879, Barrande, 'Syst. Sil. Bohêm.,' vol. v, pl. xv, fig. 4, 1–10, and pl. cxlii, fig. 8, 1–3, Ét. F.

[2] 1889, Barrois, 'Mém. Soc. Géol. Nord,' vol. iii, p. 105, pl. vi, figs. 5—5 *e*.

[3] 1879, Barrande, 'Syst. Sil. Bohêm.,' vol. v, pls. xii, xiv, xciv, cxxxiv, cxxxv, cxxxvi, and cxlii, Ét. F. and G.

1889. Athyris concentrica, *Barrois*. Mém. Soc. Géol. Nord, vol. iii, p. 113, pl. vii, figs. 3—3 *c*.

Localities.—From Lummaton about sixty-five specimens are in my Collection, three in the Torquay Museum, four in the Woodwardian Museum, one in the Bristol Museum, one in the Museum of the Geological Society. From Wolborough there are six specimens in Mr. Vicary's Collection, one in the Museum of Practical Geology.

Remarks.—The Lummaton specimens are all of small size, and must either be all young shells or a dwarfed local variety. Their folds are comparatively shallow.

On the other hand, one of Mr. Vicary's shells is very large, and has a much deeper fold than usual.

3. Athyris rugata, *Davidson*.

1882. Athyris rugata, *Davidson*. Brit. Foss. Brach., vol. v, pt. 1, p. 26, pl. i, figs. 25, 25 *a*.

? 1886. — concentrica, *Wenjukoff*. Faun. Dev. Syst. N.W. und Cent. Russl., p. 511, pl. iv, fig. 17.

Remarks.—This shell is very rare. I have two doubtful specimens from Lummaton. Dr. Davidson's type specimen came from Hope's Nose. I have nothing to add to his description.

4. ? Athyris Newtoniensis, *Davidson*.

1864. Athyris Newtoniensis, *Davidson*. Brit. Foss. Brach., vol. iii, pt. 6, p. 19, pl. iii, fig. 22.

Dr. Davidson gives this species in his list of Lummaton fossils. I only know two *very* doubtful specimens from that locality, one in my Collection and one in the Museum of Practical Geology.

5. Athyris ? Bartoniensis, *Davidson*.

1864. Athyris ? Bartoniensis, *Davidson*. Brit. Foss. Brach., vol. iii, pt. 6, p. 19, pl. iii, fig. 23.

Two large fragmentary specimens in my Collection from Lummaton may belong to this species. Davidson's type is in the Lee Collection in the British Museum.

3. *Genus*.—Bifida, *Davidson*, 1882.

1. Bifida Huntii, *Davidson*.

1882. Bifida Huntii, *Davidson*. Brit. Foss. Brach., vol. v, pt. 1, p. 28, pl. i, figs. 17—18.

Locality.—About eighteen specimens are in my Collection and one in the Woodwardian Museum from Lummaton.

Remarks.—This small but very distinct little species is not very rare, but from its small size and great fragility it is easily lost or overlooked.

It is interesting to note that the Barton specimen in Mr. Lee's Collection, originally described by Davidson as *A. lepida*, is really a very poor specimen of the present shell. Davidson's figure and description, however, were evidently completed from more perfect German specimens, and therefore still apply to *B. lepida*; and, while that species must be consequently removed from the list of Lummaton fossils, it remains a British species, as it occurs in abundance and beautiful preservation at Hope's Nose.

Affinities.—*Terebratula venusta*, Schnur,[1] seems rather similar, but is a larger shell with more numerous and less distinct ribs.

2. Bifida ? plana, n. sp. Pl. XII, figs. 8, 8 *a*, 8 *b*.

Description.—Shell very small, flat, circular. Ventral valve slightly more convex than the other. Beak erect, not recurved, small, prominent, with straight lateral margins. Area triangular, flat. Foramen apparently apical, rather large, and separated from the hinge by a high deltidium. Hinge-margin moderately convex.

Dorsal valve nearly flat, with a broad shallow depression in the centre, which is most visible near the beak. Front margin slightly invading that of the ventral valve, so that the valves meet in a shallow inverted arch.

Size.—Length 7 mm., width 10 mm., depth 2·5 mm.

Localities.—There are four specimens in my Collection from Lummaton.

Remarks.—These are very minute shells, and may possibly prove to be only the young of some other species. At the same time they appear to have several characters which are so different from those of the accompanying species that, in

[1] 1854, Schnur, 'Palæontographica,' vol. iii, p. 180, pl. xxiv, figs. 3 *a*, *b*.

the absence of evidence to the contrary, they must certainly be regarded as distinct.

It is not easy to decide to what genus they belong. From their likeness in general shape to *B. Huntii* it has seemed best to describe them provisionally as *Bifida ? plana*, though probably when better known they will have to be removed to some other genus.

The texture of the shell seems coarsely tubular.

4. *Genus.*—Retzia, *King*, 1850.

1. Retzia longirostris, *Kayser.*

1864. Retzia ferita, *Davidson* (not *von Buch*). Brit. Foss. Brach., vol. iii, pt. 6, p. 21, pl. iv, figs. 8—10.
1871. — longirostris, *Kayser*. Zeitsch. Deutsch. Geol. Gesell., vol. xxiii, p. 558, pl. x, fig. 5.
1882. — — *Davidson*. Brit. Foss. Brach., vol. v, pt. i, p. 29, pl. i, figs. 30, 31.
1885. — — *Maurer*. Abhandl. Grossh. Hessisch. Geol. Landes., vol. i, pt. 2, p. 175, pl. vii, fig. 25.

This species seems rather rare at Lummaton. I have about fifteen specimens in my Collection. Four specimens are in the Torquay Museum, one in the Woodwardian Museum, and five, including one of Davidson's figured specimens, in the British Museum.

From Wolborough two specimens are in the Museum of Practical Geology.

Remarks.—There is no doubt that *R. longirostris* is quite distinct from *R. ferita*. I question, however, whether *R. Pelmensis*, Kayser,[1] may not be a young form of it. The beak varies much in length in English specimens.

5. *Genus.*—Uncites, *Defrance*, 1827.

1. Uncites gryphus, *Schlotheim*, sp.

1820. Terebratulites gryphus, *Schlotheim*, Petref., p. 259, pl. xix, fig. 1.
1864. Uncites gryphus, *Davidson*. Brit. Foss. Brach., vol. iii, pt. 6, p. 22, pl. iv, figs. 11, 12.
1882. — — — Ibid., vol. v, pt. i, p. 30, pl. iii, figs. 4—10.

Localities.—There are four fragmentary specimens in Mr. Vicary's Collection from Wolborough, and two from Chircombe Bridge.

[1] 1871, Kayser, 'Zeitsch. Deutsch. Geol. Gesell.,' vol. xxiii, p. 556, pl. x, fig. 6.

6. *Genus.*—Spirifera, *Sowerby*, 1815.

1. Spirifera Verneuilii, *Murchison.*

1840. Spirifera Verneuilii, *Murchison.* Bull. Soc. Géol. Fr., vol. xi, p. 252, pl. ii, fig. 3.
1840. — disjuncta, *Sowerby.* Geol. Trans., ser. 2, vol. v, pt. 3, pl. liii, fig. 8, and pl. liv, figs. 12, 13.
1864. — — *Davidson* (pars). Brit. Foss. Brach., vol. iii, p. 6, pl. v, figs. 1—12 (only).
1867. — — *Hall.* Pal. N. Y., vol. iv, pt. 1, p. 243, pl. xli, figs. 1—19 and pl. xlii, figs. 1—20.
1868. Spirifer disjunctus, *Dames.* Zeitsch. Deutsch. Geol. Gesell., vol. xx, p. 494.
1882. Spirifera Verneuilii, *Davidson.* Brit. Foss. Brach., vol. v, pt. 1, p. 35, fig. 1.
1882. Spirifer Verneuili, *Barrois.* Mém. Soc. Géol. Nord, vol. ii, p. 257, pl. x, figs. 7 *a—d.*
1884. Spirifera disjuncta, *Walcott.* Pal. Eureka District Nevada, p. 134.
1886. — — (Verneuili, Archiaci, tenticulum, Brodi), *Wenjukoff.* Faun. Dev. Syst. N.W. und Cent. Russl., p. 480, pl. iii, figs. 1—7, and pl. iv, figs. 1—4.
1891. — — *Whiteaves.* Contrib. Canad. Palæont., vol. i, pt. 3, p. 221, pl. xxix, fig. 4.

Localities.—The shell figured by Davidson and one other doubtful valve are the only specimens I have found at Lummaton; but there are two more in the Woodwardian Museum from Lummaton collected by Mr. E. B. Tawney, and also two in the Torquay Museum which, from the character of their matrix, must, I think, have come from the same place. From Wolborough there is one specimen in the Museum of Practical Geology, one in my Collection, and three in the British Museum, including the originals of Phillips's fig. 127 and Davidson's pl. v, fig. 5.

? 2. Spirifera subcuspidata, *Schnur.*

1831. Spirifer subcuspidatus, *Schnur.* Program. Brach. Uebergangsgeb. Eifel., p. 11.
1864. Spirifera subcuspidata, *Davidson.* Brit. Foss. Brach., vol. iii, pt. 6, p. 33, pl. viii, figs, 14, 15.

Remarks.—Davidson quotes this species from Newton Abbot; and, as there is a poor specimen in the Museum of Practical Geology from Wolborough which belongs either to this species or to *Sp. speciosa*, I think it must have been the specimen which he described as above. Its hinge is unseen, its sinus extremely wide and concave, its ribs high and subangular, and its cardinal angles probably sharp.

Davidson includes *Sp. speciosa* in his list of fossils from Lummaton, but without remark; it has not been recognised among the fossils I have seen from that locality.

3. Spirifera undifera, *F. Römer*. Pl. XIII, figs. 6, 7.

1844. Spirifer undiferus, *F. Römer*. Rheinisch. Uebergangsgeb., p. 72, pl. vi, fig. 6.
?1859. — cyclopterus, *Hall*. Pal. N. Y., vol. iii, p. 199, pl. xxv, figs. 1 *a—z*.
1864. Spirifera undifera, *Davidson*. Brit. Foss. Brach., vol. iii, pt. 6, p. 36, pl. vii, figs. 1—10.
1882. — — *Davidson*. Ibid., vol. v, pt. 1, p. 33, pl. i, fig. 33.

Localities.—This seems a common shell. From Wolborough there are twenty-one specimens in Mr. Vicary's Collection (some of which are still larger than those figured by Davidson), twelve in the Museum of Practical Geology, and eight in the British Museum. In the Torquay Museum are twelve specimens from Barton or Lummaton. From Lummaton there is one specimen in the Museum of Practical Geology, two in the British Museum, and seventy in my Collection, of all sizes and shapes, some being very well preserved.

Remarks.—The ribs in the typical form vary considerably, being sometimes almost imperceptible and sometimes strongly defined. In a few specimens the furrows are bisected by minute threads, but this is evidently not a constant character even in the specimens that show it. In small shells the fold and sinus become very indistinct; and in my Collection, besides the above, are about sixteen heart-shaped specimens, without fold or ribs, but similar in general shape to narrow specimens of the full-grown shell, which are probably young forms of the same species.

The finer surface-markings vary considerably. Ordinarily they have the appearance of transverse lines, but in well-preserved specimens they are seen to be rows of dots or pectinations, and in one or two examples they are so much developed as to become consecutive rows of short radiating irregular lines.

Sp. cyclopterus, Hall, seems to have the transverse lines rather coarser.

4. Spirifera concinna, *Hall?* Pl. XIII, figs. 8, 8 *a*.

1859. Spirifer concinnus, *Hall*. Pal. N. Y., vol. iii, p. 200, pl. xxv, figs. 2 *a—i*.
?1864. Spirifera undifera, var. undulata, *Davidson*. Brit. Foss. Brach., vol. iii, pt. 6, p. 37, pl. vii, figs. 11—14.

Localities.—There are eight specimens in my Collection from Lummaton belonging to either Hall's or Römer's species; and several of Mr. Vicary's specimens of *Sp. undifera* are of the same shape.

Remarks.—The variety *undulata* is said to differ from *Sp. undifera* only in having strong and angular instead of slight and rounded ribs. At first sight it might well be regarded as a distinct species, but on a specimen being sent to Davidson he pronounced it a variety of Römer's shell.

Only one of my specimens has retained any part of its surface, and that is marked by fine, close, distinct, radiating lines, unbroken by any transverse markings, which imply that this specimen, at least, had a totally distinct surface character, and is identical with *Sp. concinnus*, Hall.

Davidson, however, describes the variety *undulosa* as "regularly crossed by numerous concentric ridges, as in the type *undifera*." Without further evidence it is impossible to solve the problem thus presented. Whether *Sp. concinna* should take a place in our list, by addition or substitution, I am not prepared to say; but I can hardly imagine that the specimen above mentioned can belong to *Sp. undifera* when it differs so definitely from it in its finer ornamentation; and that fossil at all events ought probably to be referred to Hall's species.

The ribs of some of my specimens are bifid near the margin.

The species named by Barrande[1] *Sp. nobilis* and *Sp. viator* only differs in having a rather wider fold.

5. Spirifera nuda, *Sowerby*.

1840. Spirifera nuda, *Sowerby*. Geol. Trans., ser. 2, vol. v, pt. 3, pl. lvii, fig. 8.
1864. — — *Davidson*. Brit. Foss. Brach., vol. iii, pt. 6, p. 38, pl. iv, figs. 17—24.

Localities.—From Lummaton forty-eight specimens are in my Collection, thirteen in the Woodwardian, four in the British Museum, and three in the Bristol Museum. From Wolborough there are five in the Museum of Practical Geology, and one in Mr. Vicary's Collection.

Remarks.—The fine transverse lines in this shell are rather coarser than those of the adjoining species, and appear to be simple ridges unbroken by serrations or imbrications.

[1] 1879, Barrande, 'Syst. Sil. Bohêm.,' vol. v, pl. vii, figs. 4—15; and pl. lxxiii, fig. 3, 1–8; and pl. cxxiv, figs. 6 *a*—*c*, Et. E.

6. Spirifera curvata, *Schlotheim*. Pl. XIII, figs. 4, 4 *a*, 5, 5 *a*.

1820. Terebratulites curvatus, *Schlotheim*. Petref., p. 280, pl. xix, figs. 2 *b*, *d*.
1859. Spirifer modestus, *Hall*. Pal. N. Y., vol. iii, p. 203, pl. xxviii, figs. 1 *a*—*f*.
1863. — inflatus, *Semenow and Möller*. Mélange Phys. et Chim., vol. v, p. 665, pl. ii, figs. 2 *a*—*c*.
1863. — glabra. Ibid., p. 685, pl. ii, figs. 5 *a*—*c*.
1864. Spirifera curvata, *Davidson*. Brit. Foss. Brach., vol. iii, pt. 6, p. 39, pl. iv, figs. 29—32, 33 ?, 34 ?, and pl. ix, figs. 26, 27.
1882 — — — Ibid., vol. v, pt. 1, p. 32, pl. i, fig. 34, and pl. ii, fig. 4.
1882. Spirifer curvatus, *Barrois*. Mém. Soc. Géol. Nord, vol. ii, p. 246.
? 1886. — inflatus, *Wenjukoff*. Fauna Dev. Syst. N. W. und Cent. Russl., p. 499, pl. xiv, fig. 15.

Localities.—This appears to be the commonest Spirifer at Lummaton. In my Collection are about 100 specimens of all shapes and sizes; there are also fifty in the Woodwardian Museum, eleven in the British Museum, three in the Museum of Practical Geology, and eleven in the Torquay Museum. From Wolborough there are nine in Mr. Vicary's Collection and one in the British Museum; and from Chircombe Bridge there is one in Mr. Vicary's Collection.

Remarks.—Some specimens show the finer ornamentation very distinctly. As a rule the valves occur united.

Maurer [1] regards *Sp. inflatus*, Schnur,[2] as a synonym of *Sp. Urii*. It seems to me more probably a young form of the narrower variety of the present species. I have shells of all sizes of both the wider and the narrower varieties, which are also linked by shells of intermediate shapes. In both cases the fold is very variable in depth, and in the smallest shells it is sometimes absent. In the latter case it is hard to decide to what species the fossils belong, but on the whole I think the evidence rather in favour of their being the young of the present species than of *Sp. lineata* or full-grown varieties of *Sp. infima*, mihi.

Sp. modestus, Hall, exactly agrees with many of my smaller specimens.

[1] 1885, Maurer, 'Abhandl. Grossh. Hessisch. Geol. Landes.,' vol. i, pt. 2, p. 155, pl. vi, figs. 12, 13.
[2] 1854, Schnur, 'Palæontographica,' vol. iii, p. 211, pl. xxxvii, figs. 2 *a*—*d*.

7. Spirifera infima, n. sp. Pl. XIII, figs. 1—3.

1882. Spirifera Urii, *Davidson* (pars). Brit. Foss. Brach., vol. v, pt. 1, p. 34.
1886. — — *Wenjukoff*. Faun. Dev. Syst. N. W. and Cent. Russl., p. 507, pl. iv, fig. 14.

Description.—Shell minute, with a slight linear sinus on the front of each valve. Dorsal valve flat, semi-oval. Ventral valve very deep. Hinge-line straight, as wide as the shell, with sharp or slightly rounded lateral angles. Area very broad, nearly horizontal. Beak very sharp, low, distant, slightly recurved. Surface smooth.

Size.—Length, 7 mm.; width, 8 mm.; depth, 5 mm.

Localities.—There are twenty examples of this little shell in my Collection, six in the Woodwardian, and two in the British Museum.

Remarks.—I hardly think that these tiny fossils can belong to the same species as the *Sp. Urii*[1] that is so abundant in the Pilton Beds. They differ from it in several particulars, as size, depth of sinus, length of hinge-line, and sharpness of lateral angles. From the species as generally known in the Upper Palæozoic they are distinguished by having sharper lateral angles and a wide receding area, over which the beak is slightly curved at its extremity. The hinge-line is as wide as the shell, and the median sinus is usually slight. Some shells, however, come nearer to the usual shape. It is possible that some of these specimens may only be the fry of other species. The sharp-angled form is, however, certainly a true species, though it was admitted by Davidson as *Sp. Urii* upon my sending it to him.

8. Spirifera lineata, *Martin*, sp.

1809. Anomites lineatus, *Martin*. Petref. Derb., p. 12, pl. xxxvi, fig. 3.
1864. Spirifera lineata, *Davidson*. Brit. Foss. Brach., vol. iii, pt. 6, p. 43, pl. iv, figs. 13—15.

Remarks.—About seventeen small and generally defective specimens from Lummaton in my Collection seem to agree in general shape with this shell, both about the umbonal parts, and in having no fold or sinus, but none of them show the characteristic lineations. That they belong to this species I am not sure. I think they are more probably immature specimens of *Sp. curvata.*

Davidson records it from Wolborough, but not from Lummaton.

[1] 1864, Davidson, 'Brit. Foss. Brach.,' vol. iii, pt. 6, p. 41, pl. iv, figs. 25—28.

9. Spirifera simplex, *Phillips*.

1841. Spirifera simplex, *Phillips*. Pal. Foss., p. 71, pl. xxix, fig. 124.
1864. — — *Davidson*. Brit. Foss. Brach., vol. iii, pt. 6, p. 46, pl. vi, figs. 18—22.
1887. Spirifer simplex, *Tschernyschew*. Mém. Com. Géol., vol. iii, pt. 3, p. 69, pl. ix, figs. 8 *a*—*d*.

Localities.—This is a rather rare species. From Lummaton I have ten specimens, and there are two in the Woodwardian Museum, one in the collection of the Geological Society, and two in the Torquay Museum. From Wolborough there are three fine specimens in Mr. Vicary's Collection, and two in the Museum of Practical Geology.

Remarks.—The shell seems covered with exceedingly fine transverse lineations.

Maurer[1] unites with it *Sp. pyramidalis*, Schnur,[2] and *Sp. nudus*, Schnur,[3] but both these show signs of ribs, of which there is no indication in any English specimen.

10. Spirifera Newtoniensis, *Davidson*.

1865. Spirifera Newtoniensis, *Davidson*. Brit. Foss. Brach., vol. iii, pt. 6, p. 40, pl. ix, fig. 21, 21 *a*.

Remarks.—The type specimen from Wolborough is, I believe, still unique. *Spirifer aviceps*, Kayser,[4] only differs in having rounded lateral angles.

7. *Sub-Genus*.—Spiriferina, *d'Orbigny*, 1847.

11. Spiriferina insculpta, *Phillips*.

1836. Spirifera insculpta, *Phillips*. Geol. Yorks., vol. ii, p. 126, pl. ix, figs. 2, 3.
1840. — pulchella, *Sow*. Geol. Trans., ser. 2, vol. v, pt. 3, pl. lvii, fig. 8.
1864. Spiriferina insculpta ? (var.), *Davidson*. Brit. Foss. Brach., vol. iii, pt. vi, p. 48, pl. vi, figs. 16, 17.
? 1879. Spirifer sulcatus (*Hisinger*), *Barrande*. Syst. Sil. Bohêm., vol. v, pl. l, figs. 17, 18; and pl. lxxv, figs. 1, 1–4, 2, 1–2 *d*, Ét. E and F.
1882. Spiriferina insculpta, *Davidson*. Brit. Foss. Brach., vol. v, pt. 1, pl. i, fig. 32.

[1] 1885, Maurer, 'Abhandl. Grossh. Hessisch. Geol. Landes.,' vol. i, pt. 2, pl. vi, figs. 15—16 *a*.
[2] 1854, Schnur, 'Palæontographica, vol. iii, p. 207, pl. xxxvi, figs. 1 *a*—*c*.
[3] Ibid., p. 208, pl. xxxvi, figs. 2 *a*—8.
[4] 1871, Kayser, 'Zeitsch. Deutsch. Geol. Gesell.,' vol. xxiii, p. 578, pl. xi, figs. 8 *a*—*g*.

1885. Spirifer gibbosus (*Barrande*), *Maurer*. Abhandl. Grossh. Hessisch. Geol. Landes., vol. i, pt. 2, p. 159, pl. vi, figs. 19—21.

Localities.—There are from Lummaton seven specimens in my Collection, five in the Woodwardian Museum, and two in the Torquay Museum. From Wolborough there is a specimen in the Torquay Museum.

Remarks.—I cannot agree with Davidson that Sowerby's *Sp. pulchella* is a variety of *Sp. nuda*. His type specimens in the Museum of the Geological Society appear to me exactly to agree with the present shell, and, moreover, they show indistinct traces of the transverse ornament, which is like that of the present species, and unlike that of *Sp. nuda*. As, however, it seems clear that the Devonian species is identical with the Carboniferous shell described by Phillips in the 'Geology of Yorkshire,' the name *Sp. pulchella* simply becomes a synonym of *Sp. insculpta*.

The shell described by Maurer as *Spirifer gibbosus*, Barrande,[1] appears to me identical, the distinctions which he draws being probably due to accidents of fossilisation or individual variation. Our specimens, for instance, do show radiating lines crossing the transverse ridges. Barrande's own shell has finer ridges and a flatter fold.

The shell given by Barrois[2] as *Sp. Jaschei*, F. A. Römer,[3] young, is very similar, and may perhaps belong to this species rather than to the German shell to which he refers it.

8. *Genus.*—Cyrtia, *Dalman*, 1828.

1. Cyrtia? Whidbornei, *Davidson*.

1882. Cyrtia? Whidbornei, *Davidson*. Brit. Foss. Brach., vol. v, pt. 1, p. 36, pl. ii, figs. 6, 7.

Localities.—From Lummaton there are eighteen specimens in my Collection, seven in the Woodwardian, one in the British Museum, and two in the Torquay Museum. One small example from Wolborough is in Mr. Vicary's Collection.

Remarks.—This is rather a variable species, being sometimes very transverse and sometimes having no lateral ribs on the dorsal valve. Occasionally the beak is slightly arched forward, so that the area becomes concave; but generally it is, as described by Davidson, flat.

[1] 1879, Barrande, 'Syst. Sil. Bohêm.,' vol. v, pl. ii, figs. 7—8*f*, Ét. E.

[2] 1889, Barrois, 'Mém. Soc. Géol. Nord,' vol. iii, p. 137, pl. ix, fig. 4.

[3] 1850, F. A. Römer, 'Beitr. Hartzgeb.,' pt. 1, p. 58, pl. ix, fig. 11.

Affinities.—The strong dorsal fold and the fine radiations at once distinguish it from *Sp. simplex*, Phillips.

Spirifer pyramidalis, Schnur,[1] differs entirely in the shape of the fold, which is more rounded, broader, and undefined, and also by the presence of transverse lineations.

9. *Genus.*—Cyrtina, *Davidson*, 1858.

1. Cyrtina heteroclita, *Defrance.* Pl. XII, figs. 11, 12.

1824. Calceola heteroclita, *Defrance*, Dict. Sci. Nat., vol. xxxii, p. 306, pl. lxxx, figs. 3, 3 *a*.
1857. Cyrtia Hamiltonensis, *Hall.* Tenth Report State Cabinet, p. 166.
1861. — — *Billings.* Dev. Foss. Canada West, p. 263.
1864. Cyrtina heteroclita, *Davidson.* Brit. Foss. Brach., vol. iii, pt. 6, p. 48, pl. ix, figs. 1—10.
1867. Cyrtia Hamiltonensis, *Hall.* Pal. N. Y., vol. iv, pt. 1, p. 268, pl. xxvii, figs. 1—4; and pl. xliv, figs. 26—52.
1868. — affinis, *Billings.* Pal. Foss., vol. ii, pt. 1, p. 49, pl. iii A, figs. 6, 6 *a*, 6 *b*.
1868. — Hamiltonensis, *Meek.* Trans. Chicago Ac. Sci., vol. i, p. 99, pl. xiv, figs. 5, 7, 10.
1879. — heteroclyta, *Barrande.* Syst. Sil. Bohêm., vol. v, pl. viii, figs. 1—6; and pl. cxxiv, fig. 3, Ét. F.
1882. Cyrtina heteroclita, *Barrois.* Mém. Soc. Géol. Nord, vol. ii, p. 260, pl. x, fig. 8 *e* (only).
1882. — — *Davidson.* Brit. Foss. Brach., vol. v, pt. 1, p. 37, pl. i, figs. 35—37.
1884. — — var. multiplicata, *Beushausen.* Abhandl. Geol. Specialk. Preuss., vol. vi, pt. 1, p. 122, pl. vi, figs. 20 *a*, *b*.
1885. — — *Maurer.* Abhandl. Grossh. Hessisch. Geol. Landes., vol. i, pt. 2, p. 162, pl. vii, figs. 3—4 *a*.
1886. — — *Œhlert.* Ann. Sci. Géol., vol. xix, p. 40, figs. 21—34.
1887. — — *Bechard.* Bull. Soc. Belge Géol., vol. i, p. 83.
1887. — — *Tschernyschew.* Mém. Com. Géol., vol. iii, pt. 3, p. 78, pl. x, figs. 15 *a*—*d*.
1889. — — *Toll.* Mém. Acad. Imp. Sci. St. Pétersbourg, ser. 7, vol. xxxvii, No. 3, p. 17, pl. i, figs. 8 *a*—*e*.
1891. — Hamiltonensis, *Whiteaves.* Contrib. Canad. Palæont., vol. i, pt. 3, p. 226, and pt. 4, p. 288.

Localities.—This is one of the commonest fossils at Lummaton, where I have collected it by hundreds, and specimens are to be seen in most museums. Two figured by Phillips are in the British Museum. From Wolborough there are

[1] 1854, Schnur, 'Palæontographica,' vol. iii, p. 207, pl. xxxvi, figs. 1 *a*—*e*.

twelve specimens in the Museum of Practical Geology, three in the British Museum, and twenty-one in Mr. Vicary's Collection.

Remarks.—The surface of the shell is covered with microscopic tubercles regularly arranged.

One aberrant specimen has the marginal part of the fold trifid, consisting of a larger between two smaller plaits. One or two other shells show some irregularity in the fold besides an approach to the character by which Davidson distinguishes *C. Demarlii.*

Another specimen has two or three oblique excentric ribs running down each slope of the ventral sinus.

It appears to me from Hall's description that *C. Hamiltonensis* is undoubtedly a synonym. The only difference which I can see is that the ribs of the American form are sometimes rather more numerous, but almost every one of Hall's figures might have been drawn from Lummaton specimens in my Collection. Similarly I can find nothing to distinguish *C. affinis*, Billings, from the English shell.

Cyrtia Dalmani, Hall,[1] comes exactly between this species and *C. heteroclita*, var. *multiplicata*, Davidson. If these two forms are distinct species I should be inclined to regard it as a synonym of the latter shell.

2. Cyrtina heteroclita, var. multiplicata, *Davidson.* Pl. XII, figs. 13, 13 *a*.

?? 1859.	Cyrtina Dalmani, *Hall.*	Pal. N. Y., vol. iii, p. 206, pl. xxiv, figs. 2 *a—y*.
1859.	— rostrata, *Hall.*	Ibid., vol. iii, p. 429, pl. xcvi, figs. 1—6.
1864.	— heteroclita, var. multiplicata, *Davidson.*	Brit. Foss. Brach., vol. iii, pt. 6, p. 49, pl. ix, figs. 11—14.
1882.	— — —	*Davidson.* Ibid., vol. v, pt. 1, p. 38, pl. ii, figs. 8—8 *c*.
1882.	— —	var. hispanica and multiplicata, *Barrois.* Mém. Soc. Géol. Nord, vol. ii, p. 260, pl. x, figs. 8 *a—d, f*.
1887.	— Demarlii, *Tschernyschew.*	Mém. Com. Géol., vol. iii, pt. 3, p. 80, pl. ix, figs. 1 *a—c*.
1889.	— heteroclyta, *Barrois.*	Mém. Soc. Géol. Nord, vol. iii, p. 126.

Localities.—From Lummaton there are five specimens in my Collection, and three in the Torquay Museum. From Wolborough there is one in the Museum of Practical Geology. Phillips's figured specimen of *Sp. cuspidata* is in the British Museum.

Remarks.—I am inclined to the opinion that this shell is distinct from *C. heteroclita.* It is distinguished by its much greater comparative width, its narrower area, and its much smaller, more numerous, and more equal ribs. Its fold is large, and is not in a nearly regularly ascending order with the other ribs as in *C. heteroclita.*

[1] 1861, Hall, 'Pal. N. Y.,' vol. iv, p. 206, pl. xxiv, figs. 2 *a—y*.

3. Cyrtina heteroclita, var. Demarlii, *Bouchard, MS.* Pl. XII, fig. 10.

1864. Cyrtina Demarlii, *Davidson.* Brit. Foss. Brach., vol. iii, pt. 6, p. 50, pl. ix, figs. 15—17.
1885. — — *Maurer.* Abhandl. Grossh. Hessisch. Geol. Landes., vol. i, pt. 2, p. 164, pl. vii, figs. 5—6 *c*.
1886. — heteroclita, var. Demarlii, *Œhlert.* Ann. Sci. Géol., vol. xix, p. 42, pl. iii, figs. 35—41.

Remarks.—Davidson seems to have established this species chiefly on specimens from Fergues, where he describes it as common. He only mentions two or three Devonshire specimens; and says that it is chiefly distinguished from *C. heteroclita* by the longitudinal groove in the centre of the mesial fold.

In my own Collection are two specimens having a distinct biplicated mesial fold, while in about a dozen there is a similar linear groove on the summit of the fold, but generally so slight as to be discernible only under a lens. In a clear specimen of *C. heteroclita*, on the other hand, I find that the mesial fold, which is simple on the upper part, becomes suddenly deeply trifid near the margin.

From the evidence, therefore, of the English specimens I should have little hesitation in following Œhlert and uniting the present species with *C. heteroclita.*

Sp. subconica, Phillips (not Sowerby), which Davidson gives as a synonym of the present form, is said only to differ from *C. heteroclita* by the narrowness of the mesial fold; and that hardly seems a distinctive feature, judging from the great variability of the latter shell.

4. Cyrtina amblygona, *Phillips*, sp.

1841. Terebratula amblygona, *Phillips.* Pal. Foss., p. 88, pl. xxxv, fig. 169.
1864. Cyrtina amblygona, *Davidson.* Brit. Foss. Brach., vol. iii, pt. 6, p. 51, vol. ix, figs. 18—20.

Remarks.—This species is evidently very rare at Lummaton, as I have never succeeded in finding a specimen of it there.

There is a single specimen in the Torquay Museum from Lummaton (?), which differs from Davidson's figures in the absence of a fold and the greater irregularity of the ribs.

The original specimen figured both by Phillips and Davidson from Barton is in the British Museum.

IV. *Family.*—Atrypidæ, *Dall*, 1871.

1. *Genus.*—Glassia, *Davidson*, 1881.

1. Glassia Whidbornei, *Davidson*. Pl. XII, figs. 7, 7 *a*, 9, 9 *a*, 9 *b*.

? 1872. Rhynchonella Beyrichi, *Kayser*. Zeitsch. Deutsch. Géol. Gesell., vol. xxiv, p. 678, pl. xxvi, figs. 6 *a*—*k*.
1882. Glassia Whidbornei, *Davidson*. Brit. Foss. Brach., vol. v, pt. 1, p. 38, pl. i, figs. 10—14.
? 1885. — Beyrichi, *Maurer*. Abhandl. Grossh. Hessisch. Geol. Landes., vol. i, pt. 2, p. 192, pl. viii, figs. 11—15.

Localities.—This shell seems rather rare at Lummaton. In my Collection are about thirty specimens, in the Woodwardian eight, in the Torquay Museum one, in the British Museum one, and in the Bristol Museum one, which seem, as far as can be judged, to belong to it. There also seem to be five specimens from Wolborough in the Museum of Practical Geology.

Remarks.—It is almost impossible to distinguish this species by external characters alone from small examples of *Waldheimia Whidbornei*, Davidson. The type-specimens were, I believe, operated upon by Mr. Glass, after having been drawn by Dr. Davidson, and therefore were destroyed as types as far as the exterior is concerned.

Maurer doubtfully refers this shell to the species described by Kayser as *Rhynchonella Beyrichi*. Kayser had informed him that he thought his shell probably belonged to the genus *Glassia;* and a specimen of it, afterwards discovered, proved this view to be correct. He states that the German shell has a less arched beak than the English form, that its spire is more circularly twisted, and that its last whorl lies nearer to the body, but he thinks these differences perhaps only indicate a local variation. It also seems to have a much larger foramen. I cannot see any distinction from the present species in the shell which he refers to *Glassia obovata*, Davidson.

2. *Genus.*—Atrypa, *Dalman*, 1828.

1. Atrypa reticularis, *Linné*, sp. Pl. XIII, fig. 10.

1767. Anomia reticularis, *Linné*. Syst. Nat., ed. xii, p. 1152.
1864. Atrypa reticularis, *Davidson*. Brit. Foss. Brach., vol. iii, pt. 6, p. 53, pl. x, figs. 3, 4.

1867. Atrypa reticularis, *Hall.* Pal. N. Y., vol. iv, pt. 1, p. 316, pl. li, figs. 10—24; pl. lii, figs. 1—12; pl. liii, figs. 3—19; pl. liii a, figs. 22, 23.

1879. — — *Barrande.* Syst. Sil. Bohêm., vol. v, pl. xix, figs. 1—19; and pl. cix, figs. 2, 1–13, Ét. E and F.

1882. — — *Davidson.* Brit. Foss. Brach., vol. v, pt. 1, p. 39, pl. i, fig. 16.

1882. — — *Barrois.* Mém. Soc. Géol. Nord, vol. ii, p. 265.

1885. — — *Maurer* (pars). Abhandl. Grossh. Hessisch. Geol. Landes., vol. i, pt. 2, p. 180, pl. vii, figs. 30, 30*a*, 37—37 *c*.

1886. — — *Stuckenburg.* Mém. Acad. Imp. Sci. St. Pétersbourg, ser. 7, vol. xxxiv, No. 1, p. 7, pl. iii, fig. 9.

1886. — — (desquamata), *Wenjukoff* Faun. Dev. Syst. N.W. und Cent. Russl., p. 514, pl. vi, figs. 1 *a*, *b*, 5 *a*, *b*, 6.

1889. — — *Toll.* Mém. Acad. Sci. St. Pétersbourg, ser. 7, vol. xxxvii, No. 3, p. 24, pl. ii, figs. 14 *a*, *b*, *d*, *e*.

1890. — — and var. aspera, *Œhlert.* Bull. Soc. Géol. Fr., ser. 3, vol. xvii, pl. xx, figs. 4—5 *a*.

1892. — — *Whiteaves.* Contrib. Canad. Palæont., vol. i, pt. 4, p. 289, pl. xxxvii, fig. 8.

Remarks.—*A. reticularis*, *A. desquamata*, *A. aspera*, *A. compressa*, are all common, and *A. trigonella* is not rare in the English Middle Devonian; but partly from their great variability, and partly from the imperfect state of most of the specimens, it is most difficult to decide their specific values or limits. I have examined very large numbers of specimens; and, while the differences are so great that it is almost impossible to imagine them all to be the same species, the connecting links are such that it is almost equally impossible to regard them as distinct.

Certain marked distinctions may be traced in shells of all sizes, and, were all our specimens perfect, it might prove possible to find clear dividing lines between them; but in the condition in which they generally occur it is often almost impossible to allocate them.

Some of the chief forms may be thus defined:

1. *A. reticularis:* beak small, narrow, much incurved, and with rounded sides; foramen nearly or entirely hidden; ribs generally fine and numerous, but sometimes coarse; shape circular, flat when young, but very globose when aged.

2. *A. desquamata* (including *A. compressa*): beak large, wide, erect; area large, wide, flat, with angular sides, and showing deltidium, which is sometimes very large; foramen well exposed, large, oval, and more or less distant from the apex

of the dorsal valve; ribs rather coarse and frequently divaricating close to the margin; shape transversely oval, and generally flattish even in large specimens.

3. *A. trigonella:* beak large, erect, narrow; area large, narrow; deltidium large; foramen large, oval, very distant from the apex of the dorsal valve; size small; shape subcircular, flattish; ribs few, very steep and subangular, divaricating, and becoming very twisted and irregular near the margins; surface covered by distant and regular foliaceous lines of growth.

4. *A. aspera:* beak incurved, small, sometimes showing foramen; shape circular, not transverse, not very globose; ribs very few and coarse, broad, very much rounded, and never divaricating; crossed by few regular, simple, nodulous ridges of growth, surmounted by foliaceous lines.

a. "4" seems distinguished from "3" by its simple, lower, and rounded rays, and its smaller beak. The coarseness of its rays distinguishes it from "1" and "2."

β. "3" seems distinguished from "1" and "2" by its constantly smaller size, and its much coarser and steeper ribs. Its large beak and area separate it from "1."

γ. Young specimens of "1" and "2" differ widely from each other in the character of the beak and area, and it is only in larger specimens that there is room for doubt. In the case of some full-grown specimens of "2" (agreeing with Sowerby's var. *compressa* and *Sp. ? affinis*, Sow.) the differences are as marked as in the young shells, as they are flat and often transverse, and the area is large and flat; in others, however, the shell is more globose and the beak incurved (cf. Davidson's Mon., vol. iii, pt. 6, pl. xi, fig. 1), and as in large specimens the beak is frequently destroyed or hidden and the surface often defective, they are sometimes most difficult to allocate.

Returning now to *A. reticularis* proper, we observe that it is (including doubtful specimens) extremely common, and often reaches a very large size. There are about 100 specimens in my Collection from Lummaton, the largest of which measures 50 mm. long, 70 mm. wide, 33 mm. deep; this, however, is one of the doubtful examples. A typical specimen is 34 mm. long, 37 mm. wide, and 22 mm. deep. There are seven specimens in the Woodwardian Museum. From Wolborough there are three specimens in Mr. Vicary's Collection, seven in the Museum of Practical Geology, and seven in the British Museum.

The ribs vary considerably in coarseness and number, but are typically very fine. I have about seven specimens which show the expanded frills. In two cases these reach a width of 26 mm. from the circumference, and even then are ended only by the fracture of the stone. There are several distinct layers of fringes, but they appear only to have been developed near the margins of the valves.

2. ATRYPA DESQUAMATA, *Sowerby*. Pl. XIII, figs. 13—15.

1840. SPIRIFER AFFINIS, *Sowerby*. Geol. Trans., ser. 2, vol. v, pt. 3, pl. lvii, fig. 11.
1840. ATRYPA DESQUAMATA, *Sowerby*. Ibid., pl. lvi, figs. 19—22.
1865. — — *Davidson*. Brit. Foss. Brach., vol. iii, pt. 6, p. 58, pl. x, figs. 9—13, and pl. xi, figs. 1—9.
1882. — — — Ibid., vol. v, pt. 1, p. 39, pl. i, figs. 15, 15 *a*.
1885. — RETICULARIS, var. EXPLANATA, DESQUAMATA, and PLANA, *Maurer*. Abhandl. Grossh. Hessisch. Geol. Landes., vol. i, pt. 2, pp. 181, 182, pl. vii, figs. 31—34.

Localities.—From Lummaton there are sixty specimens in my Collection, three in the Bristol Museum, eleven in the Woodwardian, and four in the Torquay Museum, one of which shows the beginning of a tubular frill. From Wolborough are numerous specimens in Mr. Vicary's Collection, twenty in the Museum of Practical Geology, eighteen in the British Museum (including Davidson's figured specimen, Pl. X, fig. 13, which is a very peculiar shell), and three in the Bristol Museum.

Remarks.—Sowerby has accurately figured this species under the names of *A. desquamata*, var. *compressa*, and *Spirifer affinis*, but I am not sure whether some of the specimens in the Museum of the Geological Society drawn by him as types of *A. desquamata* are not really large specimens of *A. reticularis*. Davidson, however, has clearly described the form.

Among of the chief distinctions are its flatness, its general transverseness (though some examples are circular), the frequent and sometimes strongly marked median depression in the dorsal valve, the flatness of its margins, its large flat wide area, its exposed foramen, its erect and elevated beak with angular sides, and the frequent divarication of its ribs close to the margin. These points seem fairly constant, and are especially noticeable in young shells. In my Collection is a curious small variety, in which the area is perpendicular to the dorsal valve, and the foramen is bounded by a high margin and separated by a very wide deltidium: it would, indeed, not be supposed even to be an *Atrypa* were it not united to typical shells of the present species by an unbroken chain of intermediate specimens. Some of the smaller specimens, in fact, are so like *Orthis* or *Strepto-rhynchus* that but for the characters of the beak, &c., they might readily be taken for such shells. Thus Sowerby has given the name of *Spirifer affinis* to one small example, while the shell in the Geological Society's Collection, which Davidson figures on his pl. xix, fig. 3, as "*Strophomena umbraculum?* = *Orthis tenuistriata*, Sowerby," is closely mimicked by wide examples of the present species.

As in *A. reticularis*, the ribs seem to increase in number with the size.

3. Atrypa trigonella, *Davidson*. Pl. XIII, figs. 11, 12.

1882. Atrypa ? trigonella, *Davidson*. Brit. Foss. Brach., vol. v, pt. 1, p. 40, pl. i, figs. 19, 19 *a*, *b*.
? 1886. — reticularis, var. aspera, *Œhlert*. Ann. Sci. Géol., vol. xix, p. 30, pl. ii, fig. 23.
? 1889. — aspera, *Toll*. Mém. Acad. Sci. St. Pétersbourg, ser. 3, vol. xxxvii, No. 3, p. 25, pl. ii, fig. 15.

Remarks.—About fifteen specimens in my Collection and one in the Woodwardian Museum can be referred with more or less certainty to this species, and they go to prove its close proximity to *A. reticularis*. A careful comparison of these with Davidson's type shows its trigonal shape, median depression, and truncated beak to be accidental. Its ribs are very similar in character to those of *A. aspera*, but more numerous, much steeper, and constantly divaricating. The transverse ornament is much the same but not so pronounced. The beak is high, and the area and the foramen large. The shell-structure is very thick, loose, and perishable.

Nine other small and doubtful specimens have closer ribs and a smaller umbo, and thus come halfway between it and the more typical shapes of *A. reticularis*.

Upon the whole it can only be regarded as a rather doubtful species, and is perhaps an argument in favour of uniting the whole group into a single species. It has the beak of *A. desquamata*, the transverse ornament of *A. aspera*, and to an exaggerated degree the divaricating ribs of *A. reticulata*. The specimens are all small and flat.

The ornamentation of *Atrypa insolita*, Barrande,[1] is almost exactly similar.

4. Atrypa aspera, *Schlotheim*, sp.

1813. Terebratulites asper, *Schlotheim*. Leonhard's Taschenbuch, vol. vii, pt. i, p. 74, pl. i, fig. 7.
1854. Atrypa squamifera, var. aspera, *Schnur*. Palæontographica, vol. iii, p. 181, pl. xxiv, figs. 4 *f*—*i*.
1865. — reticularis, var. aspera, *Davidson*. Brit. Foss. Brach., vol. iii, p. 57, pl. x, figs. 5—8.
1882. — aspera, *Davidson*. Brit. Foss. Brach., vol. v, pt. 1, p. 40, pl. x, fig. 5.
1882. — — *Barrois*. Mém. Soc. Géol. Nord, vol. ii, p. 265.
1885. — reticularis, var. aspera, *Maurer*. Abhandl. Grossh. Hessisch. Geol. Landes., vol. i, pt. 2, p. 183, pl. vii, figs. 35, 36.

[1] 1879, 'Syst. Sil. Bohême,' vol. v, pl. xxviii, figs. 4, 1–10, Ét. E.

1885. Atrypa aspera, *Wenjukoff*. Faun. Dev. Syst. N.W. und Cent. Russl., p. 519, pl. vi, figs. 2 *a*, *b*.
1887. — bifidæformis, *Tschernyschew*. Mém. Com. Géol., vol. iii, pt. 3, p. 83, pl. iv, fig. 20, and pl. x, figs. 14 *a*—*c*.
1891. — reticularis, *Whiteaves*. Contrib. Canad. Palæont., vol. i, pt. 3, p. 229.
?1891. — — var. aspera. Ibid., p. 229.

Remarks.—This species seems comparatively rare. I have fourteen specimens from Lummaton; eleven more are in the Woodwardian Museum, and two in the Bristol Museum. There are twelve in the Torquay Museum from that place, and two from Wolborough. Mr. Vicary has twenty specimens, and the Museum of Practical Geology eight, from Wolborough.

These specimens are of comparatively small size. The ribs are very low, coarse, rounded, and simple instead of divaricating. The regular and distant crossing ridges give the surface a nodulous appearance. The beak seems small, low, and incurved. My strong impression is that we have in this form a distinct species. It is certainly separated from *A. reticularis* proper by the group of *A. trigonella*; and, even if that form should be regarded as a variety of the former shell or of *A. desquamata* (= *A. compressa*), the shape and simplicity of the ribs in the present species may prove a distinctive feature. Passage-forms do not appear to exist.

Atrypa spinosa, Hall,[1] *A. hystrix*, Hall,[2] and *A. aspera*, v. *occidentalis*, Hall,[3] do not seem to me identical with this species, but closely allied.

5. Atrypa? Leei, *Davidson*, sp.

1882. Rhynchonella Leei, *Davidson*. Brit. Foss. Brach., vol. v, pt. 1, p. 47, pl. ii, figs. 15, 15 *a*.

Remarks.—Davidson has considerably restored the figure of the specimen which he makes the type of this species. I have no additional evidence to bring forward, as I have not found any further example. I hardly like, in view of his identification, to suggest the possibility of its being an abnormal form of *A. reticularis*, but I must confess great doubts as to whether the marginal obliteration of the ribs is not really due to the peeling away of the exterior layer of the shell, which is certainly much confused with the matrix. The careful examination of a large number of specimens of Devonian *Atrypæ* since I sent my

[1] 1867, Hall, 'Pal. N. Y.,' vol. iv, pt. 1, p. 322, pl. liii A, figs. 1—14, 18, 24, 25.
[2] Ibid., p. 326, pl. liii A, figs. 15—17.
[3] Ibid., p. 322, pl. liii A, figs. 19—21.

specimen to Davidson convinces me that it really belongs to that group, and I believe that if this point had come to light at the time that he examined it he would probably have merged it with *A. desquamata* or *A. reticularis*.

6. Atrypa flabellata, *Goldfuss, MS.*

1865. Atrypa flabellata, *Davidson.* Brit. Foss. Brach., vol. iii, pt. 6, p. 59, pl. xi, figs. 11, 12.

Remarks.—There are three fine specimens from Wolborough in the Museum of Practical Geology, two of which are Davidson's figured examples. They show the characters of the species well, and prove that the English form, at all events, is certainly distinct from *A. reticularis*. There are two poor specimens from Wolborough in Mr. Vicary's Collection, and one from Lummaton in my Collection, which shows a slight ventral sinus.

Their similarity in general shape to *Centronella Guerangeri*, de Verneuil,[1] sp., may be noted.

V. *Family.*—Rhynchonellidæ, *d'Orbigny*, 1847.

1. *Genus.*—Pentamerus, *Sowerby*, 1813.

1. Pentamerus brevirostris, *Phillips*, sp. Pl. XIII, figs. 9, 9 *a*; and Pl. XIV, figs. 1—3.

1841. Stringocephalus brevirostris, *Phillips.* Pal. Foss., p. 80, pl. xxxii, fig. 143.
? 1850. Spirifer glaber, *Bronn.* Lethæa Geogn., ed. 3, p. 325, pl. ii, figs. 16 *a*, *b*.
1865. Pentamerus brevirostris, *Davidson.* Brit. Foss. Brach., vol. iii, pt. vi, p. 72, pl. xv, figs. 1—14.
1885. — galeatus (*Dalman*), *Maurer.* Abhandl. Grossh. Hessisch. Geol. Landes., p. 214, pl. ix, figs. 1—3.
? 1885. Allorisma cancellatum, *Maurer.* Ibid., p. 232, pl. ix, figs. 35, 36.

Localities.—From Lummaton about 110 specimens are in my Collection, 14 in the Woodwardian, 8 in the Geological Society's Museum, 2 in the Bristol Museum, 4 in the Torquay Museum, and 3 in the Museum of Practical Geology, and one of Davidson's figured specimens in the British Museum. From Wolborough are 16 in Mr. Vicary's Collection, 4 in the Woodwardian, 1 in the Torquay Museum, 16

[1] 1850, de Verneuil, 'Bull. Soc. Géol. Fr.,' ser. 2, vol. vii, p. 780; and 1883, 'Bull. Soc. Étud. Sci. Angers,' p. 1, pl. i, figs. 1—11, and pl. ii, figs. 1—6.

in the Museum of Practical Geology, 8 in the British Museum, and 2 in the Geological Society's Museum.

Remarks.—From the great variability of this abundant species and the distorted condition in which it often occurs, its detached valves are often the source of great perplexity.

Davidson has shown that it is distinct from *P. galeatus*, Dalman, with which it had been united by Kayser.

The minute surface-ornament is sometimes clearly seen, and the differences in its character are somewhat puzzling. Many specimens are covered by numbers of microscopic triangular nodules arranged more or less regularly in arching lines, and so distinctive as to permit fragmentary specimens to be recognised by them. It appears to me that the ornament of the shell described by Maurer as *Allorisma cancellatum* is so similar that it may probably be only a distorted dorsal valve of the present species, especially as I have often found great difficulty in distinguishing similar valves at Lummaton from Lamellibranchs.

On the other hand, a few very large and compressed specimens in my Collection, which were identified by Davidson, show no signs of this minute tuberculation, but instead are covered in the marginal parts by almost equally fine, sharp, and regular transverse elevated lines. It seems difficult not to regard these as surface-ornaments, or to imagine them covered by pustules. Again, a similarly shaped shell has equally fine radiating lines, but in this case it is easy to reconcile them with other markings, as the surface is more worn.

Two large specimens are peculiar from their great depth and narrowness and the regularity and elongation of their narrow dorsal fold, and might perhaps, if more such specimens were found, be advantageously separated as a named variety.

P. optatus, Barrande, as given by Schnur,[1] is very like a variety of the present species, but Barrande's own figures show that it is distinguished by its more inflated sides.

A shell in Mr. Vicary's Collection from Wolborough, labelled by Salter "*Spirifer* new," has caused much perplexity, but it must, I think, really be an abnormal or distorted variety of *P. brevirostris*. I think the ridge which made Salter regard it as a Spirifer is accidental, and that it has really no true area. Its dorsal valve has a central angular depression or sinus, and might without difficulty be supposed to be a valve of this species, but there is a similar central sinus as well as a lateral one in the ventral valve. These marks, however, do not appear to be natural, but due to distortion in growth. There are signs of a strong median septum in the ventral valve and two internal processes in the dorsal valve, as in *P. brevirostris*. It almost exactly agrees with Bronn's figure of *Sp. glaber*.

[1] 1854, Schnur, 'Palæontographica,' vol. iii, p. 196, pl. xxxii, figs. 1 *a*, *b*.

2. Pentamerus biplicatus, *Schnur*. Pl. XIV, figs. 4, 4 *a*, 5.

? 1843.	Terebratula Wurmii, *F. A. Römer*.	Verst. Harzgeb., p. 19, pl. v, fig. 15.
1854.	Pentamerus biplicatus, *Schnur*.	Palæontographica, vol iii, p. 196, pl. xxxi, figs. 3 *a*, *b*.
1854.	— formosus, *Schnur*.	Ibid., p. 197, pl. xxxi, figs. 2 *a*, *b*.
1854.	— acutolobatus, *Sandberger*.	Verst. Rhein. Nassau, p. 345, pl. xxii, fig. 15.
1865.	— biplicatus, *Davidson*.	Brit. Foss. Brach., vol. iii, pt. 6, p. 73, pl. xiv, figs. 31, 32.
1867.	— — *Trenkner*.	Palæont. Novit., pt. 1, p. 18, pl. ii, figs. 38 *a*—*c*.
1867.	— acutolobatus, *Trenkner*.	Ibid., p. 19, pl. ii, figs. 37 *a*—*c*.
1868.	— galeatus, *Dames*.	Zeitsch. Deutsch. Geol. Gesell., vol. xx, p. 498.
1882.	— biplicatus, *Davidson*.	Brit. Foss. Brach., vol. v, pt. 1, p. 42, pl. ii, fig. 22.
1885.	— — *Maurer*.	Abhandl. Grossh. Hessisch. Geol. Landes., vol. i, pt. 2, p. 215, pl. ix, figs. 4—4 *b*.
1885.	— acutolobatus, *Maurer*.	Ibid., p. 216, pl. ix, figs. 5—6.
1889.	— galeatus, *Toll*.	Mém. Acad. Sci. St. Pétersbourg., ser. 7, vol. xxxvii, No. 3, p. 24, pl. ii, figs. 16 *a*, *b*, *d*, *e*.
1891.	— — *Whiteaves*.	Contrib. Canad. Palæont., vol. i, pt. 3, p. 234, pl. xxx, fig. 2.

Localities.—There are about twenty examples in my Collection and one in the Woodwardian Museum from Lummaton ; three others in the Torquay Museum, probably from the same locality ; and one from Barton in the British Museum, which was figured by Davidson. In Mr. Vicary's Collection is a rather large specimen from Wolborough, and another is in the Museum of Practical Geology.

Remarks.—Davidson had only small specimens when he first recorded this species. Since then larger examples have come to light, one of which he figured in his Supplement. The series now before me seems to give a good idea of the limits of the species. When young there is little more than a shallow rounded fold, slightly hollowed in the centre, on the ventral valve, and a corresponding sinus in the dorsal valve, which is prolonged into a kind of tongue. As the shell increases in size the central fold becomes more definitely bifid, and one or two ribs make their appearance on the lateral parts. When the shell is full grown these divisions have developed into steep rounded ribs, so that the margins meet in a deep zigzag, the central tongue of the sinus being more or less deeply indented. In this stage the shell appears exactly to agree with *P. formosus*, Schnur,

except that our examples have two ribs on the fold instead of three. As, however, Davidson figured a small specimen having a triple fold, this variation appears of no consequence. When the shell is very aged the ribs become still steeper and subangular, and then I can see no difference between it and *P. acutolobatus*, Sandberger. Considering the amount of variation in the kindred *P. brevirostris*, I have little hesitation in grouping these forms together, as they can be traced upwards by connecting links. It is, however, to be noted that the ribs are not always equally developed as the shell increases in size, some of the larger specimens retaining to a greater or less degree the comparative smoothness of the young form.

The shell seems covered near the margins with fine sharp growth-lines, which follow the zigzag curve of the margins. In two large specimens the apical part of the dorsal shell is removed, showing a median plate of a spear-shaped form consisting of two flat wings and a more prolonged triangular central ridge.

I cannot myself see any distinction between *T. Wurmii*, F. A. Römer, and young forms of this species; but, as Davidson did not identify them, I do not venture to do so without further evidence, seeing that the name of the species would then have to be changed to *P. Wurmii*.

3. Pentamerus sublinguifer, *Maurer*? Pl. XIV, figs. 6—8.

1885. Pentamerus sublinguifer, *Maurer*. Abhandl. Grossh. Hessisch. Geol. Landes., vol. i, pt. 2, p. 218, pl. ix, figs. 7—10.

Description.—Shell small, subcircular, flattish when young, subglobose when old. Ventral valve slightly convex, prolonged in the centre into a very shallow tongue-like sinus; beak small, low, incurved. Dorsal valve more or less convex, with an indistinct central fold, bounded by slight furrows. Apex of dorsal valve more or less approaching the beak in size and prominence.

Locality.—There are thirteen specimens in my Collection, and six in the Woodwardian Museum from Lummaton.

Size.—Height, 19 mm.; width, 19 mm.; depth, 15 mm.

Remarks.—My fossils are in two sets, both of which seem to fall within the limits of *P. sublinguifer*.

(1) There are eleven very small shells with almost equal beaks and wide flat folds, which are generally turned up in front, and are bounded by indistinct furrows. Though the apices are nearly equal, that of the sinus-bearing valve seems slightly

larger and more convex, and must be regarded as the beak; and hence these fossils are distinguished from the two forms previously described from Devonshire by having the fold on the dorsal instead of the ventral valve.

(2) There are two larger but imperfect specimens, which seem to have more unequal apices, but to agree with the former set in having the fold on the dorsal valve. They appear very similar to Maurer's types. The dorsal valve is seen to be very much swollen, and to be almost angular transversely and very convex longitudinally. The character of the sinus is the same as in Maurer's figures.

It seemed to me that both these forms should be referred to Maurer's species, and I am confirmed in my view by finding some specimens of intermediate size and characters in the Woodwardian Museum.

The beaks of the young form are generally much more equal than in the German shell, but as the beaks of small specimens of *P. brevirostris* are sometimes nearly equal I do not think much weight can be given to this character.

2. *Genus.*—Conchidium, *Linné*, 1760.

Gypidia, *Dalman*, 1828.

Beak elongate, slightly recurved. Dorsal valve having separate excentric and diverging septa, bearing the crura; ventral valve as in *Pentamerus*.

1. Conchidium britannicum, n. sp. Pl. XIV, figs. 9, 9 *a*, 9 *b*.

Description.—Shell small, gibbous, very inequivalved. Ventral valve convex, inversely cordate, regularly arching from the beak to the front. Beak extremely elevated, slightly incurved, flattened. Apex sharp, very distant. Fissure large, broad, triangular, apparently bordered by a short area. Cardinal slopes broad, slightly concave. Ventral valve slightly channelled on the back by a small narrow sinus which extends from the beak to the front margin, and obliquely flattened on each side. Front margin concave in the centre and convex on each side. Surface covered with very numerous fine, sharp, irregularly alternating, distant and divaricating, elevated rays, which are also seen on the sides of the beak, and which are more than fifty in number. Structure massive.

Size of ventral valve: height, 14 mm.; width, 16 mm.; depth, 7 mm.

Locality.—A single specimen of the ventral valve from Lummaton is in my Collection.

Remarks.—This curious little fossil is very distinct from any other British Devonian Brachiopod I have seen. I am very doubtful about its true position. Its bad state of preservation renders its characters obscure. In many features it bears decided likeness to *Skenidium areola*, but its resemblance to the American fossil described by Ulrich as *Gypidia unguiformis*[1] is so great as to suggest that it is allied to that species, though differing in several points, *e. g.* in having much more numerous ribs, a sharper and rather less elevated beak, and longitudinal ribs on the sides of the beak. In the same particulars it differs from *Conchidium biloculare*, Linné,[2] the type of Linné's genus, and still more so from *Pentamerus Knightii*, Sowerby. Even if this be so, it is still questionable what generic name it should bear. Ulrich remarks of his shell and *Gypidia conchidium*, Dalman, that both differ from *Pentamerus* proper in having the beak much more extended and slightly arcuate, and the septum of the dorsal valve separate. These points are also more or less to be observed in *P. Knightii*. On the other hand, Œhlert gives *Pentamerus* and *Gypidia* as synonyms of *Conchidium*. To follow him would be to sink the well-known name *Pentamerus;* and it certainly seems to me that these shells could hardly be included in the same category as *P. brevirostris*, &c. I should therefore be inclined to retain *Conchidium* for this group (perhaps including with them *P. Knightii*), and *Pentamerus* for the more ordinary forms. Should the distinction between them not be more than subgeneric, Dalman's and Sowerby's names might be taken as subgeneric terms under Linné's genus.

3. *Genus.*—Stricklandinia, *Billings*, 1863.

1. Stricklandinia ? sp. Pl. XVII, fig. 9.

Description.—Dorsal valve small, slightly convex, with an elevated angular mesial fold. Beak of dorsal valve minute; hinge-margin wide, nearly straight. Surface marked with numerous elevated ribs, about thirteen of which start from the hinge-line, each of which divaricates again and again as they approach the front, remaining the same size throughout; the central rib at the umbo thus dividing into about eight ribs which cover the fold.

Size of dorsal valve: about 12 mm. long and 13 mm. wide.

Locality.—A single fragmentary specimen is in my Collection from Lummaton.

Remarks.—The ornament on this fossil is very peculiar, and different from any other British Devonian shell known to me. Unfortunately my only specimen is so

[1] 1886, Ulrich, 'Contrib. American Palæont.,' vol. i, p. 28, pl. iii, figs. 2—2 *b*.

[2] 1887, Fischer, 'Manuel Conchyl.,' p. 1311, fig. 1007

fragmentary that its true nature can only be surmised. It is distinguished by its sharp triangular fold, and by the peculiar grouping of the ribs due to the frequent divarication.

In character it most reminds one of *Stricklandinia lirata*, but it is too fragmentary to permit its being referred to this genus with any degree of certainty.

4. *Genus.*—Rhynchonella, *Fischer*, 1809.

1. Rhynchonella acuminata, *Martin*, sp.

1809.	Anomites acuminatus,	*Martin.*		Petrif. Derb., p. 13, pl. xxxii, figs. 7, 8, and pl. xxxiii, figs. 5, 6.
1865.	Rhynchonella acuminata,	*Davidson.*		Brit. Foss. Brach., vol. iii, pt. 6, p. 60, pl. xiii, figs. 16—21.
1882.	—	—	—	Ibid., vol. v, pt. 1, p. 46, pl. ii, figs. 18—20.
1884.	—	—	*Tschernyschew.*	Mém. Com. Géol., vol. i, No. 3, p. 21, pl. iii, fig. 14.
1885.	—	—	*Maurer.*	Abhandl. Grossh. Hessisch. Geol. Landes., vol. i, pt. 2, p. 206, pl. viii, figs. 33—36 *a*.
1886.	—	—	*Wenjukoff.*	Faun. Dev. Syst. N.W. und Cent. Russl., p. 539, pl. v, figs. 9 *a*, *b*.
1887.	—	—	*Tschernyschew.*	Mém. Com. Géol., vol. iii, No. 3, p. 86.
1889.	—	—	var. platyloba, *Toll.*	Mém. Acad. Sci. St. Pétersbourg, ser. 7, vol. xxxvii, No. 3, p. 21, pl. ii, figs. 9, 10.

Localities.—I have collected many large specimens from Lummaton, and there are three in the Woodwardian Museum. From Wolborough there are two in the Torquay Museum, three in Mr. Vicary's Collection, three in the Museum of Practical Geology, four in the British Museum, and one in the Bristol Museum.

Remarks.—It occurs of all shapes; sometimes having a narrow sharp fold and compressed sides, sometimes having a broad, rounded, plaited fold, and sometimes being very wide and flattened.

Besides the larger specimens I have found numerous small shells at Lummaton, which are more or less lenticular, and seem to be the young of this species.

2. Rhynchonella reniformis, *Sowerby*, sp.

1825. Terebratula reniformis, *Sowerby*. Min. Conch., vol. v, p. 154, pl. ccccxcvi, figs. 1—4.
1865. Rhynchonella reniformis, *Davidson*. Brit. Foss. Brach., vol. iii, pt. 6, p. 62, pl. xiii, figs. 6, 7.

Localities.—From Wolborough five specimens in Mr. Vicary's Collection and one in the Museum of Practical Geology appear to belong to this species. Davidson figured a specimen from Lummaton in Mr. Champernowne's Collection.

Remarks.—I have found no specimens at Lummaton which I can certainly identify with this species; those I formerly referred to it I now regard as transverse examples of *Camarophoria Phillipsii*, and I am rather doubtful whether Mr. Champernowne's fossil might not prove the same. However, as Davidson has so identified it, the species must remain in the Lummaton list. The specimen in the Museum of Practical Geology seems to agree with the Carboniferous form.

3. Rhynchonella pugnus, *Martin*, sp.

1809. Anomites pugnus, *Martin*. Petrif. Derb., p. 13, pl. xxii, figs. 4, 5.
1865. Rhynchonella pugnus, *Davidson* (pars). Brit. Foss. Brach., vol. iii, pt. 6, p. 63, pl. xiii, figs. 8—10 (only).
1866. — Missouriensis, *Meek*. Geol. Surv. Illin., vol. ii, p. 153, pl. xiv, figs. 4 *a*, *b* (*fide* Whiteaves).
1885. — pugnus, *Maurer*. Abhandl. Grossh. Hessisch. Geol. Landes., vol. i, pt. 2, p. 203, pl. viii, figs. 29, 30.
1891. — — *Whiteaves*. Contrib. Canad. Palæont., vol. i, pt. 3, p. 230.

Localities.—From Lummaton there are eight specimens in my Collection, one in the Woodwardian Museum, one in the Torquay Museum, and two in the Museum of the Geological Society. One of Davidson's figured specimens from Barton is in the British Museum. From Wolborough there are two specimens in Mr. Vicary's Collection, and one in the Bristol Museum.

4. Rhynchonella triloba, *Sowerby*, sp.

1840. Atrypa triloba, *Sowerby*. Geol. Trans., ser. 2, vol. v, pt. 3, pl. lvi, fig. 14.
1854. Terebratula fornicata, *Schnur*. Palæontographica, vol. iii, p. 177, pl. xxiii, figs. 1 *a*—*e*.
1865. Rhynchonella triloba, *Davidson*. Brit. Foss. Brach., vol. iii, pt. 6, p. 64, pl. xii, figs. 1—7.
1882. — — — Ibid., vol. v, pt. 1, p. 47, pl. ii, fig. 21.
1885. — — *Maurer*. Abhandl. Grossh. Hessisch. Geol. Landes., vol. i, pt. 2, p. 210, pl. ix, figs. 39—40 *a*.

Localities.—From Lummaton there are twenty-five specimens in my Collection, three in the Woodwardian, and two (?) in the Torquay Museum. From Wolborough there are seven fine specimens in Mr. Vicary's Collection, four in the Museum of Practical Geology, and one in the British Museum.

Remarks.—My specimens show various degrees of development, some approaching the flat variety figured by Davidson in his Supplement. Besides the above I have found some very small flat specimens at Lummaton which probably are the young form.

Maurer identifies *Rh. fornicata*, Schnur, sp., with this species.

5. Rhynchonella triloboides, n. sp. Pl. XV, fig. 3.

Description.—Shell sub-oval, very transverse, with rounded angles. Beak small, recurved, narrow, and rather elevated, with arching sides. Ventral valve rather convex, with a broad central sinus, which is well marked in front. Dorsal valve equally convex both vertically and horizontally, bearing a broad, low but very distinct, rounded fold. Lateral margins deeply convex. Front margin gently convex. Surface ornamented with rather numerous elevated, rounded ribs, which are very irregular and unequal in size and direction, and do not seem to reach quite to the apex.

Size.—Length, 18 mm.; width, 23 mm.; depth, 13 mm.

Locality.—I have ten specimens from Lummaton, most of which, however, are very imperfect.

Remarks.—This shell approaches *Rh. triloba* on the side of Sowerby's *Atrypa latissima*. Mons. Œhlert, however, intimates to me that it cannot be classed with that species, and my specimens are clearly distinguishable in several particulars, *e. g.* the much sharper and more elegant beak, the more irregular, larger, and fewer ribs, the lower and more defined fold, the more convex vertical dorsal contour, and the less produced front margin.

6. Rhynchonella Neapolitana, n. sp. Pl. XV, figs. 4, 4 *a*, 4 *b*.

Cf. 1858. Rhynchonella flexistria, *Davidson*. Brit. Foss. Brach., vol. ii, pt. 5, p. 105, pl. xxiv, figs. 1—8.

Description.—Shell of moderate size, sub-globose, sub-circular. Beak ? Dorsal valve swollen, convex in contour, bearing a strong median fold. Ventral valve less convex than dorsal valve. Ribs, about twenty-six, sharp, deep, largest on the fold, rather irregular and arching on the sides, extending to umbones. Front margin convex.

Size.—Length, 23 mm.; width, 23 mm.; depth, 16 mm.

Locality.—There is a single specimen from Newton in the Museum of Practical Geology.

Remarks.—I have failed in referring this elegant shell to any known Devonian species. Perhaps the shell it most resembles is *Rh. subcuboides* from Lummaton; but from that it differs (I think specifically) in its size, in the sharpness of the ribs, and in the ribs reaching to the umbones. It appears to bear considerable resemblance to the Carboniferous *Rh. flexistria*, Phillips, but to have more equal and simple ribs.

Mons. Œhlert informs me that *Rh. Gosseleti*[1] differs from it by having fewer and dichotomising ribs.

The trivial name is from the classic form of the word "Newton."

7. Rhynchonella parallelepipeda, *Bronn*, Pl. XV, figs. 10, 10 *a*.

1835. Terebratula parallelepipeda, *Bronn*. Leth. Geogn., vol. i, p. 71, pl. ii, figs. 11 *a*—*d*.

1853. — angulosa, *Steininger*. Geogn. Beschr. Eifel, p. 59, pl. v, figs. 6 *a*—*c*.

1854. — angulosa, *Schnur*. Palæontographica, vol. iii, p. 185, pl. xxv, figs. 5 *a*, *b*.

1854. — subcordiformis, *Schnur*. Ibid., p. 186, pl. xxv, figs. 6 *a*—*c*, *h*—*k* (only).

1865. Rhynchonella primipilaris, *Davidson*. Brit. Foss. Brach., vol. iii, pt. 6, p. 66, pl. xiv, figs. 4—6.

1882. — parallelepida, *Davidson*. Ibid., vol. v, pt. 1, p. 42.

1882. — parallelepipeda, *Barrois*. Mém. Soc. Géol. Nord, vol. ii, p. 266.

1885. — — *Maurer*. Abhandl. Grossh. Hessisch. Geol. Landes., vol. i, pt. 2, p. 194, pl. viii, figs. 16, 16 *a*.

1885. — subcordiformis, *Maurer*. Ibid., p. 195, pl. viii, figs. 17, 17 *a*.

[1] 1893, Œhlert, 'Ann. Soc. Géol. Belg.,' vol. xx, p. 125, pl. iii, figs. 5—7.

Localities.—This species is very abundant at Lummaton. More than one hundred specimens are in my Collection, four in the Torquay Museum, thirty-three in the Woodwardian Museum. From Wolborough there are sixteen specimens in Mr. Vicary's Collection, two of which are larger than any figured by Davidson, and eight in the Museum of Practical Geology.

Remarks.—This is a peculiar, elegant, and distinctive form, though whether the two adjoining shapes *Rh. implexa* and *Rh. angularis* are really distinct species remains, as Davidson left it, a matter of doubt. It varies considerably in transverseness, being typically as long as wide, but occasionally slightly longer, and frequently, as described by Davidson, wider. Its fold also varies in prominence.

The species is distinguished by its pentangular shape; by the peculiar character of its various contours; by the low, rounded, close-set ribs, which vanish near the beaks; by the vertical straightness of the centre of the dorsal valve; by the flat margins of the valves which are suddenly perpendicular to the rest of their surface; by the furrowing of the ribs *only* on this flat marginal area; and by the elevated and little recurved beak. The lofty beak and the large ventral valve at once distinguish it from shells of the *Rh. cuboides* type. This beak is narrow and deep and has gracefully concave sides. The deltidium is long and narrow, and the foramen, if present, must be very small and very distant from the apex of the dorsal valve, but it seems to me that it was most probably closed, at least in the adult shell. It is, however, very difficult to obtain a specimen with the extremity of the beak entirely uninjured. The substance of the shell is rather thick.

Whether Kayser is right in regarding *Rh. primipilaris*, von Buch, as differentiated from this species by its dichotomous ribs is left rather doubtful by Davidson. In some of our specimens the ribs occasionally dichotomise, though not to the extent indicated by Schnur's figure,[1] or seen in German specimens of *Rh. primipilaris* in the Woodwardian Museum, which strongly support the correctness of Kayser's view.

Should the present species ultimately prove the same as *Rh. implexa*, Sowerby (which, however, I do not at all expect), Sowerby's name would of course have priority over Bronn's.

8. Rhynchonella implexa, *Sowerby*, sp.

1840. Atrypa implexa, *Sowerby*. Geol. Trans., ser. 2, vol. v, pt. 3, pl. lvii, fig. 4.
? 1854. Terebratula tetratoma, *Schnur*. Palæontographica, vol. iii, p. 176, pl. xxiii, figs. 4 *a*—*d*.
1854. — subcordiformis, *Schnur* (pars). Ibid., p. 186, pl. xxv, figs. 6 *d*—*g* (only).

[1] 1854, Schnur, 'Palæontographica,' vol. iii, p. 187, pl. xxvi, figs. 3 *a*—*c*.

1865.	Rhynchonella	implexa, *Davidson*.	Brit. Foss. Brach., vol. iii, pt. 6, p. 67, pl. xiv, figs. 7—10.
1871.	—	parallelepipeda, var. pentagona, "*Goldfuss*," *Kayser*.	Zeitsch. Deutsch. Geol. Gesell., vol. xxiii, p. 507, pl. ix, fig. 4.
? 1871.	—	tetratoma, *Kayser*.	Ibid., p. 526.
1881.	—	Ibergensis, *Kayser*.	Zeitsch. Deutsch. Geol. Gesell., vol. xxxiii, p. 332, pl. xix, figs. 2—3 *a*.
? 1885.	—	tetratoma, *Maurer*.	Abhandl. Grossh. Hessisch. Geol. Landes., vol. i, pt. 2, p. 195, pl. viii, figs. 18, 18 *a*.
1885.	—	pentagona, *Maurer*.	Ibid., p. 196, pl. viii, figs. 19—19 *b*.

Localities.—This shell is less common at Lummaton than *Rh. parallelepipeda*. There are thirty-five specimens in my Collection, eighteen in the Woodwardian Museum, two in the Bristol Museum, and three in the Torquay Museum. From Wolborough there are five specimens in Mr. Vicary's Collection, five in the Museum of Practical Geology, and two in the British Museum.

Remarks.—A comparison of my specimens inclines me to the belief that this shell is distinct from *Rh. parallelepipeda*. It has no fold on the dorsal valve, and only in younger specimens a slight sinus on the ventral valve; the contour of the dorsal valve is slightly convex instead of slightly sigmoidal; the margins of the valves are less abruptly flattened and more definitely toothed; the plaits are fewer, sharper, higher, and extending to the beaks; and the beaks are smaller and less elevated. The arrangement of the plaits is remarkable, the four or five median plaits which represent the fold being continued to the beak, while the lateral plaits are truncated against their sides, so that those nearest to them are short, and only the more distant ones reach the beak. The front of the shell is slightly concave, and in large shells the dorsal valve has a slight sinus instead of a fold. As these differences are constant I think they can only be explained on the supposition that we have here a distinct species. It is a smaller shell than Bronn's species, but specimens occasionally reach a fair size, and then the difference in the shape becomes still more marked. Even in smaller shells it is sufficiently distinct, though occasionally in this case specimens of rather a doubtful nature occur.

Three or four of my smaller specimens incline me to the belief that *Rh. pentagona*, Goldfuss, as given by Maurer, and possibly also *Rh. tetratoma*, Schnur, sp., and Maurer, are nothing more than small or young forms of the present shell, which seems to have sometimes had a slight fold when young. Some of the figured specimens of *Rh. subcordiformis*, Schnur, clearly belong to this species.

I am strongly of opinion that *Rh. Ibergensis*, Kayser, is simply an aged form or large local variety of this shell. Of the points by which he distinguished it,

the only one that seems to have any force is the sharpness of the lateral angles. In other respects it exactly corresponds to some of my largest specimens, though somewhat surpassing them in size. The divarication of the ribs seems rather more regular in the German shell, but it occurs in one of Davidson's figures, and in some of my larger shells. The marginal truncation is a marked feature of the species.

9. Rhynchonella angularis, *Phillips*, sp.

1841. Terebratula angularis, *Phillips*. Pal. Foss., p. 89, pl. xxxv, fig. 162.
1843. — primipilaris, *F. A. Römer*. Verst. Harzgeb., p. 18, pl. v, figs. 10 *a—c*.
1865. Rhynchonella angularis, *Davidson*. Brit. Foss. Brach., vol. iii, pt. 6, p. 68, pl. xiv, figs. 11—13.
1885. — — *Maurer*. Abhandl. Grossh. Hessisch. Geol. Landes., vol. i, pt. 2, p. 198, pl. viii, figs. 21—22 *b*.

Localities.—From Lummaton I have five specimens; another is in the Torquay Museum, and four in the Woodwardian Museum. From Barton there are three in the British Museum, of which two have been figured by Davidson. From Wolborough there are five poor specimens in Mr. Vicary's Collection, and one of Phillips's figured specimens in the Museum of Practical Geology.

Remarks.—This form is rare, but sufficient specimens exist to show that it is not a mere accident. My examples agree precisely with the three figured by Davidson, except that in one of them there is rather more thickening and flattening of the margins, and that they are not quite so transverse.

In general characters the shell very closely approximates *Rh. implexa;* the chief points of difference being its angularity, its still fewer and coarser ribs, the existence of a slight fold (which is rather exaggerated in Davidson's figure), and the large size of the beak. Whether these differences indicate that it is more than a variety is a question that must remain undecided until a larger number of specimens can be examined.

10. Rhynchonella? anisodonta, *Phillips*, sp. Pl. XV, figs. 1, 1 *a*, 1 *b*, 2.

1841. Terebratula anisodonta, *Phillips*. Pal. Foss., p. 86, pl. xxxiv, fig. 154.
??1854. Rhynchonella hexatoma, *Schnur*. Palæontographica, vol. iii, p. 176, pl. xxiii, figs. 2 *a—g*.

1865. TEREBRATULA PUGNUS, var. ANISODONTA, *Davidson*. Brit. Foss. Brach., vol. iii, pt. 6, p. 63, pl. xii, figs. 12—14.

? 1879. — CORVINA, *Barrande*. Syst. Sil. Bohêm., vol. v, pl. xxix, figs. 2—3 *a*, Ét. F.

1882. — ANISODONTA, *Davidson*. Brit. Foss. Brach., vol. v, pt. 1, p. 46.

1885. — PUGNUS, var. ANISODONTA, *Maurer*. Abhandl. Grossh. Hessisch. Geol. Landes., vol. i, pt. 2, p. 204, pl. viii, figs. 31, 32.

Localities.—From Lummaton there are twenty-six specimens in my Collection, and two in the Woodwardian. From Barton there are two in the British Museum. From Wolborough there are four in Mr. Vicary's Collection, seven in the Museum of Practical Geology, and one in my Collection.

Remarks.—I adhere to my opinion[1] that this shell is distinct from *Rh. pugnus*. Not only is its general form very distinctive, being very transverse and having a broad flat fold and very receding wings, both bearing very large and deep angular ribs, but it is covered by a peculiar minor ornamentation unlike anything I can discover on Carboniferous specimens of *Rh. pugnus*. This consists of minute, close rounded, undulating, and divaricating riblets, separated by impressed lines, and covers the whole surface; from ten to twenty of these riblets are on the space of a single rib.

Terebratula hexatoma, Schnur,[2] is possibly only a narrower variety of the present species. Its ribs are rather finer, longer, and more numerous.

Camorophoria Tschernyschewi, Toll,[3] possesses a similar minute ornament.

11. RHYNCHONELLA ? OGWELLIENSIS, *Davidson*. Pl. XVI, figs. 5, 5 *a*, 5 *b*.

1854. TEREBRATULA BIJUGATA, *Schnur* (pars). Palæontographica, vol. iii, p. 178, pl. xxiii, figs. 7 *f*—*h* (only).

1865. RHYNCHONELLA ? OGWELLIENSIS, *Davidson*. Brit. Foss. Brach., vol. iii, pt. 6, p. 69, pl. xiv, figs. 23—26.

1882. — — *Davidson*. Ibid., vol. v, pt. 1, p. 44, pl. ii, fig. 16.

Localities.—I have thirteen specimens from Lummaton, agreeing specifically with the specimen figured by Davidson in his Supplement, and there are three in the Woodwardian Museum.

Remarks.—Davidson had some doubt as to the distinctness of this species from

[1] 1882, Davidson, 'Brit. Foss. Brach.,' vol. v, pt. 1, p. 46.

[2] 1854, Schnur, 'Palæontographica,' vol. iii, p. 176, pl. xxiii, figs. 2 *a*—*g*.

[3] 1889, Toll., 'Mém. Acad. Imp. Sci. St.-Pétersbourg,' ser. 7, vol. xxxviii, No. 3, p. 23, pl. ii, figs. 1—5.

C. rhomboidea; but he ultimately came to the conclusion that the shell which he figured seemed to belong to a "distinct and well marked species." My other specimens (several of which are equally fine) bear out this view. They are totally different from *C. Lummatonensis*, with which Kayser and Maurer would unite *C. rhomboidea*, while the differences which will be noted under the latter head seem to prove that they are clearly separable from that shell also.

A shell figured by Schnur, and doubtfully referred to his *Rh. bijugata*, appears to me to belong to the present species.

5. *Sub-genus.*—Wilsonia, *Quenstedt*, 1871.

1. Wilsonia cuboides, *Sowerby*, sp. Pl. XV, figs. 6, 6 *a*.

1840.	Atrypa cuboides,		*Sowerby.*	Geol. Trans., ser. 2, vol. v, pt. 3, pl. lvi, fig. 24.
? 1854.	Rhynchonella pugnoides,		*Schnur.*	Palæontographica, vol. iii, p. 177, pl. xxiii, figs. 5 *a—e*.
1865.	—	cuboides,	*Davidson.*	Brit. Foss. Brach., vol. iii, pt. 6, p. 65, pl. xiii, figs. 17—21.
1882.	—	—	—	Ibid., vol. v, pt. i, p. 46, pl. ii, figs. 18, 19.
1884.	—	—	*Clarke.*	Neues Jahrb. f. Min., Beil.-Band iii, p. 385.
1885.	—	—	*Maurer.*	Abhandl. Grossh. Hessisch. Geol. Landes., vol. i, pt. 2, p. 199, pl. viii, figs. 23—25 *b*.
1885.	—	pugnoides,	*Maurer.*	Ibid., p. 203, pl. viii, figs. 29, 29 *a*.
1887.	—	cuboides,	*Tschernyschew.*	Mém. Com. Géol., vol. iii, pt. 3, p. 93, pl. xiv, figs. 1 *a—d*.
1891.	—	—	*Whiteaves.*	Contrib. Canad. Palæont., vol. i, pt. 3, p. 231.

Localities.—It is abundant both at Lummaton and Barton and at Wolborough; from the former place about eighty specimens are in my Collection, eight in the Woodwardian, one in the Torquay Museum, three in the Museum of Practical Geology, one (figured by Phillips, fig. 152, and by Davidson) in the British Museum, five in the Museum of the Geological Society (including Phillips's figured specimen of *Rh. crenulata*), and eight in the Bristol Museum. From Wolborough there are twenty specimens in Mr. Vicary's Collection, four in the Torquay Museum, sixteen in the Museum of Practical Geology, and two in the British Museum.

Remarks.—It is to be observed that the present species is undoubtedly the true *Rh. cuboides* of Sowerby and Davidson, and that foreign specimens must stand or fall (as species) according to their agreement with it.

I fully agree with Davidson's view that the *A. impleta* and *A. crenulata* of

Sowerby, in the 'Geol. Trans.,' are nothing more than shapes of *Rh. cuboides*. The species seems sufficiently distinct, and, while varying in width and in the number of its ribs, is marked by its low and small beak, its shallow ventral valve with high reflexed shoulders, its dorsal contour, which is slightly convex above and rather rounded below, and by the depression of its lower margins and the median lineations on the ribs in that part.

Rh. pugnoides, Schnur, seems to agree with this form rather than with *Rh. pugnus*.

There is very little difference from it in *Rh. procuboides*, Kayser,[1] as shown by the fact that that learned author, while referring Davidson's figure of the Lummaton shell to *Rh. cuboides*,[2] quotes the shell as found by himself at Lummaton as *Rh. procuboides*.[3] I am not, however, prepared to question his differentiation of the Eifel shell, but only to maintain that the Lummaton shell is the true *Rh. cuboides*.

Whiteaves (loc. cit.) has some interesting remarks on the synonymy, in which he includes *Rh. intermedia*, Barrois, *Rh. Emmonsi*, Hall and Whitfield, and *Rh. venustula*, Hall.

2. Wilsonia omega, n. sp. Pl. XV, figs. 5, 5 *a*, 5 *b*.

Cf. 1867. Rhynchonella venustula, *Hall*. Pal. N. Y., vol. iv, p. 346, pl. liv A, figs. 24—43.

Description.—Shell spheroidal. Beak rather large, narrow, and recurved. Dorsal evenly convex, with a low narrow fold. Ventral valve rather deep, with oblique sides. Lateral margins straight. Front margin very much elevated, forming a high rectangular sinus. Ribs short and widely grooved near the margins.

Size.—Height, 17 mm.; width, 18 mm.; depth, 16 mm.

Remarks.—Sowerby, in the 'Geol. Trans.,' figures a shell of Mr. Hennah's, now in the Collection of the Geological Society, under the name of *A. sphærica*. This specimen Davidson regards as a Silurian fossil accidentally mixed with Mr. Hennah's specimens, and therefore excludes it from the Devonshire lists. In the Wenlock Limestone are found specimens which he considers identical, and refers to as *Rh. Wilsoni*, var. *Davidsoni*, M'Coy, as Sowerby had himself described

[1] 1871, Kayser, 'Zeitsch. Deutsch. Geol. Gesell.,' vol. xxiii, p. 513, pl. ix, figs. 3 *a*, *b*; and 1883, Kayser in Richtofen's 'China,' vol. iv, p. 78, pl. ix, fig. 2 = *Rh. cuboides* in 1854, Schnur, 'Palæontographica,' vol. iii, pl. xlv, fig. 4 (only).

[2] 1871, Kayser, Zeitsch. Deutsch. Geol. Gesell., vol. xxiii, p. 514.

[3] 1889, Kayser, 'Neues Jahrb. f. Min.,' Band i, p. 186.

a variety of *Rh. deflexa* under the name *Rh. sphærica* in the 'Min. Conch.,' previously to giving it to Mr. Hennah's fossil. On examining Mr. Hennah's specimen I find its mineral character such that I have no doubt of the correctness of Davidson's view.

Among my Lummaton shells I have a specimen which bears considerable likeness to that shell, while differing very decidedly from ordinary specimens of *Rh. cuboides*. There are only two other specimens in my Collection which at all approach it, and they are not in a sufficiently good state of preservation to be certainly referred to it rather than to *Rh. cuboides;* but there is a good specimen from Wolborough in Mr. Vicary's Collection. Two similar Devonian fossils in the Museum of the Geological Society are there labelled *Rh. Wilsoni*. This evidence, however, appears too slight for introducing a Silurian name into the Devonian lists.

Rh. nucleolata, Hall,[1] bears considerable resemblance to it, but the fold is somewhat deeper or more advanced in profile. On the other hand, *Rh. venustula*, Hall, which Clarke[2] calls the American variety of *Rh. cuboides*, seems to me intermediate between Sowerby's species and the present shell, though differing from the latter in having a smaller beak. Mons. Œhlert considers our shell distinct from both.

Rh. fallaciosa, Bayle, sp.,[3] as described by Œhlert,[4] chiefly differs in having sharper ribs extending to the umbones.

Rh. sub-Wilsoni, d'Orbigny,[5] which somewhat resembles it in shape, has much more numerous ribs.

6. *Genus.*—Camarophoria, *King*,[6] 1846.

1. Camarophoria ascendens, *Steininger*, sp. Pl. XV, figs. 7—9.

1853. Terebratula ascendens, *Steininger*. Geogn. Beichr. Eifel, p. 61, pl. v, figs. 2—3 *c*.

1858. Rhynchonella subcuboides, *Giebel* (not *d'Orbigny*). Sil. Faun. Unterharz., p. 40, pl. v, fig. 7.

1878. — — *Kayser*. Abhandl. Geol. Specialk. Preuss., vol. ii, pt. 4, p. 155, pl. xxvi, fig. 14.

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[1] 1861, Hall, 'Pal. N. Y.,' vol. iii, p. 226, pl. xxxi, figs. 1 *a—f*, 2 *a—y*.

[2] 1884, Clarke, 'Neues Jahrb. f. Min.,' Beil.-Band iii, p. 385.

[3] 1878, Bayle, 'Expl. cart. Geol.,' pl. xiii, figs. 13—16.

[4] 1884, Œhlert, 'Bull. Soc. Géol. Fr.,' ser. 3, vol. xii, p. 420, pl. xviii, figs. 5 *a—o*.

[5] 1847, d'Orbigny, 'Prodrome,' vol. i, p. 92; and 1884, Œhlert, 'Bull. Soc. Géol. Fr.,' ser. 3, vol. xii, p. 427, pl. xxi, figs. 1—1 *s*.

[6] Not *Stenoschisma* according to Waagen, 'Mem. Geol. Surv. India,' ser. 13, vol. i, p. 435, 1887.

1879. RHYNCHONELLA MATERCULA, *Barrande*. Syst. Sil. Bohême, vol. v, pl. xxxiv, figs. 5—14; pl. cxiii, fig. 2, 1–22; and pl. cxxxv, fig. 5, Ét. F.

1879. — PALUMBINA, *Barrande*. Ibid., pl. cxiii, fig. 3, 1–11, Ét. F.

1884. — PROTRACTA, *Clarke*. Neues Jahrb. f. Min., Beil.-Band iii, p. 386.

1885. — SUBCUBOIDES, *Maurer*. Abhandl. Grossh. Hessisch. Geol. Landes., vol. i, pt. 2, p. 200, pl. viii, figs. 26—28.

1889. — CUBOIDES?, *Toll*. Mém. Acad. Sci. St. Pétersbourg, ser. 7, vol. xxxvii, No. 3, p. 22, pl. ii, figs. 11 *a*, *d*, *o*.

Description.—Shell small, sub-globose, sub-pentagonal, generally nearly as long as wide. Umbo small, sharp, slightly curved. Dorsal valve convex above, straight below; mesial fold flat, elevated, with steep sides; sides of the valve rather dilate. Ventral valve flat, narrow, with a rather abrupt sinus below, its lateral margins sigmoid and its front margin much elevated and forming a rectangle. Deltidium apparently wide; foramen minute and situate immediately under the point of the beak, at a distance from the dorsal valve. Ribs rounded, close, rather low, numerous, not reaching to the umbones, four or five on the fold and eight or ten on each side, not grooved near the margins. Margins thickened and duplicated in old shells; sometimes having fringes or expansions.

Size.—Length, 15 mm.; width, 15 mm.; depth, 10 mm.

Localities.—I have about twenty-eight specimens from Lummaton, and there is one from Wolborough in the Museum of Practical Geology.

Remarks.—These small shells at first sight seem like young specimens of *Rh. cuboides*, and as such I presume they have been hitherto regarded. They, however, may be distinguished from that species by several characters. Thus the beak is rather higher, the angle of its sides is less obtuse, the fold is much narrower and more pronounced, and bears much fewer ribs, the shape is more pentagonal, the centre of the front margin is lower, and the ribs never have a central groove. In general appearance it comes midway between *Rh. cuboides* and *Rh. parallelepipeda*. That it is not a young form is proved by the character of its margins, the duplication of which is never seen in the two last-mentioned species. It appears exactly to agree with the figures of *Rh. subcuboides*, Giebel, given by himself and by Maurer; with those given by Kayser it is not quite so similar, as the sides of the beak in them are straighter and broader. It is evidently the same as Steininger's *T. ascendens*.

Affinities.—It approaches very near to *Rh. microrhyncha*, F. Römer,[1] as given

[1] 1844, F. Römer, 'Rhein. Uebergangsgeb.,' p. 65, pl. v, figs. 2 *a*—*c*.

by Schnur;[1] the chief differences being that the fold is less arched, and that its sides are much less sharply divided from its wings. Römer's original shell is further distinguished by its sharper and more irregular ribs.

The marginal expansions seen in some Lummaton specimens and in Barrande's figures emphasize its strong resemblance to *Camarophoria crumena*, Martin, sp.[2]

I cannot agree with Clarke and Kayser that *C. ascendens* is identical with *C. protracta*, Sowerby, sp., though no doubt they are akin. Sowerby's shell, if I understand Davidson rightly, is much more elongate, has a longer beak and deeper ventral valve, and differs in some other particulars.

Rh. Ferquensis, Gosselet,[3] seems to differ in having sharper ribs, which extend to the umbones.

Camarophoria ascendens, *Steininger*, sp. (Young form).

Description.—Shell small, circular, lenticular. Dorsal valve slightly convex, with a very broad, flat, and slightly elevated central fold. Ventral valve equally convex with the other valve, mesial sinus hardly perceptible, except at the margin. Margins meeting at an acute angle. Surface covered with numerous low, rounded, flat ribs, extending from the umbo and arching out laterally toward the margins. Beak elevated, incurved.

Size.—Length, 10 mm.; width, 11 mm.; depth, 5 mm.

Localities.—There are fourteen specimens in my Collection from Lummaton.

Remarks.—These small specimens have long puzzled me. They evidently are not related to either *Rh. parallelepipeda* or *Rh. implexa*. I questioned whether they might be a young form of *Rh. cuboides*, but the more convex ventral valve, the loftier beak, and the more acute apical angle, beside one or two other points, make it clear that they could not belong to that species. When we come to *Rh. subcuboides*, however, we find most of these distinctions disappear, the chief differences remaining being the flatness of the shell and the small development of the mesial fold and sinus. I find that there are some specimens in both groups where these distinctions are less marked, and therefore I have little hesitation in regarding them as identical.

At the same time, as the relationship is not apparent at first sight, I have thought it worth while to give a separate description of the present form, in case further evidence should arise to prove its distinctness.

[1] 1854, Schnur, 'Palæontographica,' vol. iii, p. 173, pl. xxii, figs. 3 *a*—*d*.

[2] 1858, Davidson, 'Brit. Foss. Brach.,' vol. ii, p. 113, pl. xxv, figs. 3—9.

[3] 1887, Gosselet, 'Ann. Soc. Géol. Nord,' vol. xiv, p. 199, pl. i, figs. 1—9.

2. Camarophoria protracta, *Sowerby*, sp.

1840. Atrypa protracta, *Sowerby*. Geol. Trans., ser. 2, vol. v, pt. 3, pl. lvi, fig. 16.
1865. Rhynchonella protracta, *Davidson*. Brit. Foss. Brach., vol. iii, pt. 6, p. 69, pl. xiv, figs. 27—29.
1882. — — *Davidson*. Ibid., vol. v, pt. 1, p. 44, pl. ii, fig. 17.
1885. Camarophoria ? protracta, *Maurer*. Abhandl. Grossh. Hessisch. Geol. Landes., vol. i, pt. 2, p. 212, pl. viii, figs. 41—41 *b*.
? 1889. Rhynchonella, n. sp., *Toll*. Mém. Acad. Sci. St. Pétersbourg, ser. 7, vol. xxxvii, No. 3, p. 22, pl. ii, figs. 6—8.

Localities.—There are six specimens of different sizes in my Collection from Lummaton.

Remarks.—I have nothing to add about this shell. It seems distinguished from *C. Phillipsii* by the great relative elongation of its fold forwards, the greater convexity of its central dorsal contour, and by the greater number and stronger character both of its median and lateral ribs.

3. Camarophoria Lummatonensis, *Davidson*.

1865. Rhynchonella ? Lummatonensis, *Davidson*. Brit. Foss. Brach., vol. iii, pt. 6, p. 70, pl. xiv, figs. 14—18.
1885. Camarophoria rhomboidea, *Maurer*. Abhandl. Grossh. Hessisch. Geol. Landes., vol. i, pt. 2, p. 211, pl. viii, figs. 42—44 *b*.

Localities.—From Lummaton there are eighty-five specimens in my Collection, ten in the Woodwardian Museum, one in the British Museum, three in the Bristol Museum, and two in the Torquay Museum. There is a very doubtful specimen from Wolborough in Mr. Vicary's Collection, and two in the British Museum.

Remarks.—This little species in its typical form is very distinct. Maurer unites it with *C. rhomboidea*, Phillips (with which he also seems to join *Rh. Ogwelliensis*), but I believe that Davidson is correct in regarding his three species as distinct. The present shell is distinguished from *Rh. Ogwelliensis*, by its higher, narrower beak, its much more numerous, deeper, and angular plaits, and the much greater straightness of its dorsal contour. I have not material for such a complete comparison of it with Devonshire specimens of *C. rhomboidea*, but it may,

I think, be distinguished by the number and angularity of its plaits. The specimens which Maurer figures as *C. rhomboidea* appear to belong to the present species. In general shape it bears some resemblance to *Rh. ? anisodonta*.

Terebratula brachyptycta, Schnur,[1] approaches it, but is a less triangular shell with a more convex front margin.

4. Camarophoria ? rhomboidea, *Phillips*, sp. Pl. XVI, figs. 3, 3 *a*, 3 *b*, 4, 4 *a*.

1841.	Terebratula	rhomboidea,	*Phillips*.	Pal. Foss., p. 88, pl. xxxv, fig. 158.
? 1843.	—	seminula,	*F. A. Römer* (not *Phillips ?*).[2]	Verst. Harzgeb., p. 17, pl. v, figs. 17 *a*—*e*.
1843.	—	rhomboidea,	*F. A. Römer*.	Verst. Harzgeb., p. 16, pl. v, figs. 24 *a*, *b*, 25.
1854.	—	bijugata,	*Schnur*.	Palæontographica, vol. iii, p. 178, pl. xxiii, figs. 7 *a*—*e*.
1865.	Camarophoria	rhomboidea,	*Davidson*.	Brit. Foss. Brach., vol. iii, pt. 6, p. 70, pl. xiv, figs. 19—22.
1882.	—	? —	*Davidson*.	Ibid., vol. v, pt. 1, p. 48.
1887.	—	—	*Tschernyschew*.	Mém. Com. Géol., vol. iii, pt. 3, p. 79, pl. iv, figs. 10, 12.

Localities.—From Barton are five specimens in the British Museum (including the originals of Phillips's fig. 158, and Davidson's pl. xiv, fig. 21). There are two very fine specimens in the Torquay Museum, and three in the Bristol Museum (which are typical but without any locality, and may be foreign shells). I have twenty-three specimens from Lummaton, and there are six in the Woodwardian Museum. From Wolborough there are two specimens in Mr. Vicary's Collection.

Remarks.—My own specimens are generally small and indistinct, and I see on them very little indication of any median septum. The larger specimens in the Torquay and Bristol Museums are just like Davidson's figures.

Judging from my specimens, it differs from *Rh. Ogwelliensis* by its sharper and narrower beak with more arching sides, by the greater curvature of the lateral margins, by the straighter vertical contour of the dorsal fold, and by the greater prolongation of the front margin.

From *C. Lummatonensis* it is distinguished by having fewer and much more rounded ribs, which are low rounded folds instead of sharp angular plaits.

[1] 1854, Schnur, ' Palæontographica,' vol. iii, p. 178, pl. xxiii, figs. 6 *a*—*c*.

[2] 1837, Phillips, ' Geol. Yorks.,' vol. ii, p. 222, pl. xii, figs. 21—23.

I am, therefore, inclined to follow Davidson in regarding it as distinct from both these species.

Rh. bijugata, Schnur, only differs in being a rather larger shell, and appears to be identical.

5. Camarophoria Phillipsii, *Davidson*, sp. Pl. XVI, figs. 1, 1 *a*, 1 *b*, 2, 2 *a*.

1882. Rhynchonella Phillipsii, *Davidson*. Brit. Foss. Brach., vol. v, pt. 1, p. 43, pl. ii, fig. 14.

Localities.—From Lummaton I have eight specimens, as well as eighteen smaller flat shells which I believe to be the young of this species. There are two specimens in the Woodwardian Museum, and one in the Torquay Museum. There is a specimen from Wolborough in the Torquay Museum, and another in the Museum of Practical Geology.

Remarks.—I believe this may be regarded as a well-established species. Comparing my larger specimens (some of which I formerly regarded as *Rh. reniformis*, from their likeness to the shell figured by Davidson in his vol. iii, pt. 6, pl. xiii, fig. 6), they appear to have a general specific resemblance though showing considerable variation in detail. The ribs on the median fold are either four or five, though in one instance, at least, they are reduced to two by partial amalgamation. The shell is sometimes considerably transverse. The straightness of the median dorsal contour, and the presence of rather indistinct lateral ribs, as well as other features, distinguish it from *Rh. pugnus* and *Rh. reniformis* respectively. Its transverseness and its less elongated central part distinguish it from *Rh. protracta*.

More common than the larger form is a small, flat, subtriangular, wedge-shaped shell, with little or no fold or sinus, but with four or five low, round, close ribs on the central part, while the lateral parts are smooth. The beaks are more erect, and the hinge part of the margins straighter; but these points seem probably due to age, and in some of the specimens there are indications of a low angular fold. These evidently all belong to one species, and are of such a shape as might naturally be expected in the young form, while some specimens come midway between, so that it is not easy to assign them to either group. At the same time it is to be noted that one of my shells, which presents all the characters of the adult, is as small as any of the wedge-shaped form. These young shells, it is true, closely resemble one of Davidson's figures of the young of *Rh. acuminata*; but I cannot trace any link between them and Devonian specimens of the latter shell. Moreover, within the beak (both of the young and adult

shapes) are converging dental plates, united so as to form a wedge-shaped septum and chamber in the ventral valve. As this shows that they belong to the genus *Camarophoria*, I have no hesitation in regarding all these specimens as specifically identical.

6. Camarophoria cf. megistana, *Le Hon*, sp.

? 1870. Terebratula megistana, *Le Hon*. Bull. Soc. Géol. Fr., ser. 2, vol. xxvii, p. 496, pl. xi, figs. 7, 8.
? 1887. Camarophoria megistana, *Tschernyschew*. Mém. Com. Géol., vol. iii, pt. 3, p. 98, pl. ix, figs. 9—11.

Remarks.—Two very large specimens from Lummaton in my Collection bear considerable likeness to Le Hon's species as given by Tschernyschew. They are very transverse shells, with a broad flattish fold, which is convex longitudinally, and which bears rather numerous ribs near the margin. The sides of the shell seem dilate and drooping. The specimens are unfortunately too obscure for identification or figuring.

VI. *Family.*—Koninckinidæ, *Davidson*, 1853.

1. *Genus.*—Davidsonia, *Bouchard*, 1849.

1. Davidsonia Verneuilii, *Bouchard.*

1849. Davidsonia Verneuilii, *Bouchard*. Ann. Sci. Nat., ser. 3, vol. xii, p. 92, pl. i, figs. 2, 2 *a*.
1865. — — *Davidson*. Brit. Foss. Brach., vol. iii, pt. 6, p. 74, pl. xi, figs. 13—16, and pl. xv, fig. 18.
1885. — Verneuili, *Maurer*. Abhandl. Grossh. Hessisch. Geol. Landes., vol. i, pt. 2, p. 139, pl. v, figs. 11, 11 *a*.

Remarks.—This species does not seem to have been very rare at Wolborough. I have observed ten or twelve specimens adhering to various shells in Mr. Vicary's Collection and in the Museum of Practical Geology.

VII. *Family.*—Strophomenidæ, *King*, 1846.

1. *Genus.*—Skenidium, *Hall*, 1860.

1. Skenidium areola, *Quenstedt*, sp. Pl. XVII, figs. 7, 8.

? 1854. Orthis plicatella, *Schnur*. Palæontographica, vol. iii, p. 219, pl. xxxviii, figs. 4 *a—c*.
? 1869. — lepidus, *Hall*. Pal. N. Y., vol. iv, pt. 2, p. 46, pl. vi, figs. 1 *a—f*.
1871. — areola, *Quenstedt*. Petref. Deutsch., Band ii, p. 589, pl. lvii, fig. 27.
1882. Skenidium areola, *Davidson*. Brit. Foss. Brach., vol. v, pt. 1, p. 49, pl. iii, figs. 11—14.
1885. — — *Maurer*. Abhandl. Grossh. Hessisch. Geol. Landes., vol. i, pt. 2, p. 141, pl. v, figs. 12—13 *b*.
1892. — — *Hall*. Pal. N. Y., vol. viii, pt. 1, p. 243, pl. vii A, fig. 43.

Locality.—There are sixteen specimens in my Collection, from Lummaton, chiefly detached valves.

Size.—A dorsal valve measures 11 mm. wide.

Remarks.—The specimen figured by Davidson is smaller, and has fewer and more prominent and unequal ribs than the shell as figured by German authors; but some of my specimens vary in the opposite direction, and, indeed, the difference is so great that it is possible that the English fossils may include two species or varieties. My larger specimens, besides the variation in ribbing, seem to have rather a lower and smaller beak. Some of these specimens so nearly resemble *Orthis plicatella*, Schnur, that there is little doubt of their identity, but it is not so certain whether these agree specifically with Quenstedt's species.

Orthis lepidus, Hall, seems to differ only in having rather finer and more equal ribs than the English specimens of the same size, and may perhaps be nothing more than a dwarfed variety.

2. *Genus.*—Orthis, *Dalman*, 1828.

1. Orthis striatula, *Schlotheim*, sp.

1813. Terebratulites striatulus, *Schlotheim*. Leonhard's Min. Taschenbuch, vol. vii, pt. 1, pl. i, fig. 6.
1867. Orthis striatula, *Davidson*. Brit. Foss. Brach., vol. iii, pt. 6, p. 87, pl. xvii, figs. 4—7.

1882.	Orthis striatula,	*Barrois.*	Mém. Soc. Géol. Nord, vol. ii, p. 233.
1883.	—	— *Kayser.*	Richtofen's China, vol. iv, p. 90, pl. iii, fig. 1.
1885.	—	— *Maurer.*	Abhandl. Grossh. Hessisch. Geol. Landes., vol. i, pt. 2, p. 133, pl. v, figs. 3, 4.
1886.	—	— *Wenjukoff.*	Faun. Dev. Syst. N.W. und Central Russl., p. 465.
1887.	—	(Schizophoria) striatula, *Œhlert.*	In Fischer's Manuel Conch., p. 1287, fig. 1055.
1889.	—	striatula, *Toll.*	Mém. Acad. Sci. St. Pétersbourg, ser. 7, vol. xxxvii, No. 3, p. 18, pl. i, figs. 10 *a—d*.
1891.	—	— *Whiteaves.*	Contrib. Canad. Palæont., vol. i, pt. 3, p. 218.

Remarks.—I have nothing to add to the description of this shell. It does not appear very common at Lummaton, from which locality there are six specimens in the Torquay Museum, eight in my Collection, and two, which were figured by Davidson, in the British Museum.

It falls under the genus or group *Schizophoria*, King, 1850.

Orthis oblata, Hall,[1] seems very similar, but its hinge and beak are apparently smaller.

Orthis Penelope, Hall,[2] is perhaps identical, but seems to have more definite transverse markings.

O. Tulliensis, Vanuxem,[3] seems to be a more globose form.

O. Iowensis, Billings,[4] is considered by H. S. Williams[5] and by Whiteaves as a western variety of this shell.

2. Orthis? sp. Pl. XVII, fig. 5.

Description.—Dorsal valve large, convex, circular, apparently bearing two large perpendicular dental plates. Surface with ten or twelve very low and broad, close, rounded ribs, only discernible in the central parts, the whole surface being covered by about 150 minute, distant, elevated, rounded, radiating striæ, which run rather irregularly, and are very unequal in size and occasionally divaricate.

Size of valve.—About 25 mm. long, 27 mm. wide, and 9 mm. deep.

[1] 1859, Hall, 'Pal. N. Y.,' vol. iii, p. 162, pl. x, figs. 1—22.

[2] 1860, Hall, '13th Report State Cab.,' p. 79; and 1867, 'Pal. N. Y.,' vol. iv, pt. 1, p. 50, pl. vi, figs. 2 *a—m*.

[3] 1843, Vanuxem, 'Geol. Rept. Third District N. Y.,' p. 163.

[4] 1859, Billings, in 'Hind's Rept. Assinib. Saskatch.,' p. 187, fig. 1 *a*.

[5] 1889, H. S. Williams, 'American Geologist,' vol. iii, p. 232.

Locality.—A single specimen is in my Collection from Lummaton.

Remarks.—Whether this is a variation of *O. striatula* or a distinct species is not clear from the specimen, which is defective all round the margins. The striæ are similar to those in that species, except that there are no signs of spines; their grouping, however, gives it a distinct character, which suggests a relationship to the genus *Meekella*.[1]

3. Orthis Eifliensis, *de Verneuil.*

1850. Orthis Eifeliensis, *de Verneuil.* Bull. Soc. Géol. Fr., ser. 2, vol. vii, p 161.
1868. — sacculus, *Dames.* Zeitsch. Deutsch. Geol. Gesell., vol. xx, p. 499.
1882. — Eifliensis, *Davidson.* Brit. Foss. Brach., vol. v, pt. 1, p. 50, pl. iii, figs. 16 *a*—*e*.
1882. — Eifeliensis, *Barrois.* Mém. Soc. Géol. Nord, vol. ii, p. 235.

Locality.—I have fourteen specimens of this shell from Lummaton, and there is another very fine example in the Torquay Museum.

Size.—Length 11 mm., width 13 mm., depth 4 mm.

Remarks.—I have nothing to add to Davidson's description of this shell.

Orthis venustula, Barrande,[2] is rather closely akin, if not identical.

4. Orthis pulcherrima, n. sp. Pl. XVII, figs. 6, 6 *a*, 6 *b*.

Description.—Shell transversely oval, convex, almost equivalve. Hinge-line straight, much shorter than the width of the shell. Beaks prominent, almost equal, much incurved and rounded, that of the dorsal valve being proximate, and that of the ventral valve being separated from the hinge by a broad triangular area. Valves nearly equal, gibbous and prominent near the beaks, and slightly convex toward the other margins, where they meet at a small angle. Front margin of the ventral valve depressed by a slight continuous sinus. Surface covered with about twenty-five large sub-triangular elevated ribs, separated by similar interspaces, the whole apparently being crossed by transverse striæ or growth-lines.

Size.—Length, 15 mm.; width, 19 mm.; height, 10 mm.

Locality.—Lummaton. A single specimen is in my Collection.

Remarks.—This specimen is undoubtedly distinct, and is certainly new to our Devonshire list. It is at once distinguishable by its sub-equal valves and beaks,

[1] 1868, White and St. John, 'Trans. Chicago Acad. Sci.,' vol. i, p. 120, figs. 4—6.

[2] 1879, Barrande, 'Syst. Sil. Bohêm.,' vol. v, pl. lxiv, fig. 4, 1–2*g*, Ét. E.

by its cordate section, and especially by its coarse triangular ribs. The nearest approach to it which I have seen is a specimen of *Orthis hybrida* in Dr. Davidson's Collection, but its ribs are very much coarser than those of that shell. It appears to belong to the group *Schizophoria*.

3. *Genus*.—Orthotetes, *Fischer de Waldheim*, 1830.

Streptorhynchus, *King*, 1850.

Waagen, Hall, Œhlert, and others restrict *Streptorhynchus* to shells with a high triangular area and shorter hinge-line, which belong to newer Palæozoic formations. In view, however, of the extreme variation of the height and width of the area in *O. distortus*, it seems to be impossible that these points can here have generic importance. Hall[1] having, however, proved that Fischer's name has priority, I substitute it, though with great regret, for the more usual appellation of the genus. Davidson,[2] quoting Waagen, had left the question of priority open; at the same time suggesting that *Orthotetes*, *Streptorhynchus*, and *Derbyia* may prove congeneric.

1. Orthotetes umbraculum, *Schlotheim*, sp.

1820.	Terebratulites umbraculum, *Schlotheim*.	Petref., p. 256.
1843.	Orthis umbraculum, *F. A. Römer*.	Verst. Harzgeb., p. 11, pl. iv, fig. 4.
1864.	Streptorhynchus umbraculum, *Davidson*.	Brit. Foss. Brach., vol. iii, pt. 6, p. 76, pl. xvi, fig. 6, and pl. xviii, figs. 1—5.
1882.	— umbraculum, *Barrois*.	Mém. Soc. Géol. Nord, vol. ii, p. 239, pl. ix, fig. 2.
1886.	— crenistria, *Stuckenberg*.	Mém. Acad. Imp. Sci. St. Pétersbourg, ser. 7, vol. xxxiv, No. 1, p. 6, pl. iii, figs. 1—5.
1886.	— umbraculum, *Wenjukoff*.	Fauna Dev. Syst. N.W. und Central Russl., p. 469, pl. ii, fig. 15.
1887.	— — *Bechard*.	Bull. Soc. Belge Géol., vol. i, p. 86.
1887.	Orthothetes umbraculum, *Œhlert*.	In Fischer's Manuel Conch., p. 1285, fig. 1049.
?1892.	— Woolworthiana, *Hall*.	Pal. N. Y., vol. viii, pl. ix, figs. 25—31.

[1] 1892, Hall, 'Pal. N. Y.,' vol. viii, pt. 1, p. 256.

[2] 1884, Davidson, 'Brit. Foss. Brach.,' vol. vi, p. 379.

Localities.—Eighteen specimens from Lummaton, and one from Wolborough are in my Collection; three from Lummaton, and four from Wolborough in the Torquay Museum; five from Wolborough in Mr. Vicary's Collection; three from Wolborough in the British Museum.

Remarks.—My Lummaton specimens are of large size, but do not preserve the minor transverse striæ. Wolborough specimens are frequently of the form of moulds, retaining, however, the outer layer of shell, and the ribs are in that case so deeply impressed as to give a very different aspect to the fossil. Davidson, however, evidently regards them as all belonging to the present species, and none of the fossils that I have seen give any evidence to shake this view or to add to the details of his description.

From *Strophomena pecten* it is distinguished by the broader hinge-area and larger pseudo-deltidium of the ventral valve, and by the linear hinge-area without any pseudo-deltidium of the dorsal valve. The question of the identity of *St. crenistria* still remains where Davidson left it.

The ornament in the various varieties of *O. Chemungensis*, Conrad,[1] seem finer and more even, and the internal marks different.

2. Orthotetes distortus, *Barrande*, sp. Pl. XVII, fig. 2.

1879. Orthis distorta, *Barrande*. Syst. Sil. Bohême, vol. v, pl. lviii, figs. 4—5*f*, pl. lx, fig. 4, 1—9; pl. cvii, fig. 6; pl. cxxvii, fig. 2, 1, Ét. F.

1887. Streptorhynchus umbraculum, var. torta, *Œhlert*. Ann. Sci. Géol., vol. xix, p. 57, pl. iv, figs. 24—28.

1889. Orthis distorta, *Whidborne*. Geol. Mag., dec. 3, vol. vi, p. 78.

Description.—Shell rather small, sub-convex, very much distorted. Beak rather prominent, laterally twisted. Surface covered by very numerous alternating, distant, rounded, elevated ribs, the interspaces between which become wider as they reach the margins.

Size.—Length, 17 mm.; width, 20 mm.; depth, 12 mm.

Locality.—There are two specimens in my Collection from Lummaton.

Remarks.—This shell is chiefly remarkable for the extreme irregularity of its shape. It was first identified in my Collection by Mr. Marr, and a comparison, made by him, with Bohemian fossils in the Woodwardian Museum, left no doubt of its identity with Barrande's species.

[1] 1867, Hall, 'Pal. N. Y.,' vol. iv, pt. 1, p. 67, pls. iv, ix, and x.

Orthis deformis, Hall,[1] has much finer and closer ribs.

Some forms of *Streptorhynchus Chemungensis*, Conrad,[2] sp., are considerably distorted, but their ornament seems finer and more even, though sometimes when the striæ are in a double series the major striæ give a very coarse appearance to the surface.[3]

Whether it is more than a variety of *O. umbraculum* seems doubtful, but until further evidence is collected there are hardly sufficient data for uniting it with Schlotheim's shell.

Davidson[4] has figured similarly distorted examples of *Streptorhynchus crenistria*, Phillips, sp.

Hall[5] remarks that the distortion of the ventral valve in the genus *Derbyia* is much greater than in that of *Orthotetes*, and species of that genus closely resemble the present shell. He regards this distortion as an evidence that the shell was attached when young.

4. *Genus.*—Strophomena, *de Blainville*, 1825.

Hall,[6] in the last volume of his 'Pal. N. Y.,' has elaborately discussed the historic claims of the terms *Strophomena*, *Leptæna*, &c., coming to the conclusion that *Strophomena* should be restricted to shells of the type of *St. rugosa*, Rafinesque (which is supposed to = *Leptæna planumbona*, Hall); *Leptæna* to shells of the type of *St. rhomboidalis*; *Rafinesquina*, Hall, to shells of the type of *L. alternata*, Conrad; and *Plectambonites*, Pander, to shells of the type of *L. transversalis*. These changes would cause much confusion among the multitudes of described species, as Davidson and Saller have been almost universally followed in taking *St. rhomboidalis* as the type-form of *Strophomena*, and *L. transversalis* as that of *Leptæna*. It seems unadvisable to introduce such extensive changes unless the evidence is conclusive, and Hall's evidence is certainly not more than presumptive. The whole question hangs on the meaning of the type-species "*St. rugosa*, Rafinesque." Rafinesque does not appear to have described his shell himself, and even the identity of the species primarily described under that name by de Blainville is shrouded in uncertainty. It is generally supposed to be *L. planumbona*, Hall; but Hall himself mentions the important fact that specimens of *St. rhomboidalis* in Rafinesque's own Collection bore the labels of *Strophomena*

[1] 1859, Hall, 'Pal. N. Y.,' vol. iii, p. 174, pl. x A, figs. 13 *a*, *b*; and pl. xv, figs. 3 *a*, *b*.

[2] 1867, ibid., vol. iv, pt. 1, p. 67, pl. x, figs. 13—18.

[3] Ibid., figs. 4, 6.

[4] 1859, Davidson, 'Brit. Foss. Brach.,' vol. ii, p. 124, pl. xxvii, figs. 2, 5.

[5] 1892, Hall, 'Pal. N. Y.,' vol. viii, pt. 1, p. 263.

[6] Ibid, p. 245, 276, &c.

rugosa ; and hence it is at least uncertain whether he himself did not intend the latter species by his name, even though Blainville's interpretation scarcely seems to represent that shell. Moreover de Blainville, who first published a specific but not a generic description, refers to an English geniculated species of the genus, meaning probably *St. rhomboidalis*. Consequently there seems no sufficient reason for overthrowing Davidson's nomenclature, which, whether it should ultimately prove to be strictly in accord with the laws of priority or not, is both well established and clear.

In 1828 Dalman formed the genus *Leptæna* for the three shells—*Leptæna rhomboidalis*, *L. euglypha*, and *L. transversalis*. If *L. rhomboidalis* be reserved for the genus *Strophomena*, there seems no reason why Davidson may not be followed in taking *L. transversalis* as the type of *Leptæna*.

1. Strophomena rhomboidalis, *Wilckens*, var. analoga, *Phillips*.

1769. Conchita rhomboidalis, *Wilckens*. Nachtricht v. seltenen Verst., p. 77, pl. viii, figs. 43, 44.
1836. Producta analoga, *Phillips*. Geol. Yorks., vol. ii, p. 215, pl. vii, fig. 10.
1859. Strophomena rugosa (*Phillips*), *Hall*. Pal. N. Y., vol. iii, p. 195, pl. xix, figs. 1 *a*—*y*.
1865. — rhomboidalis, var. analoga, *Davidson*. Brit. Foss. Brach., vol. iii, pt. 6, p. 76, pl. xv, figs. 15—17.
1867. — — *Hall*. Pal. N. Y., vol. iv, pt. 1, pp. 76 and 414, pl. xii, figs. 16—18? and pl. xv, figs. 15, 16.
1879. — — *Barrande*. Syst. Sil. Bohêm., vol. v, pl. xli, figs. 1—38 ; pl. lv, fig. 3, 1, 2 ; pl. xcii, figs. 1—3 *a*, Ét. E, F.
1887. — — *Tschernyschew*. Mém. Com. Géol., vol. iii, pt. iii, p. 108, pl. xiv, fig. 25.
1887. Plectambonites rhomboidalis, *Œhlert*. In Fischer's Manuel Conch., p. 1283, fig. 1048.
1889. — — *Nicholson*. Manual Palæont., vol. i, p. 663, fig. 518.
1892. Leptæna rhomboidalis, *Hall*. Pal. N. Y., vol. viii, pt. 1, p. 279, pl. viii, figs. 17—31 ; pl. xv A, figs. 40—42 ; and pl. xx, figs. 21—25.

Localities.—From Lummaton fifteen specimens are in my Collection, and eight in the Woodwardian Museum. From Wolborough there are eight fine typical and similar specimens in Mr. Vicary's Collection, one in the Museum of Practical Geology, and one in the British Museum.

Remarks.—Unlike *St. nodulosa*, the rugæ on young specimens are as prominent

as in older shells. The radiating threads are distant, prominent, and comparatively coarse.

5. *Genus.*—Stropheodonta, *Hall*, 1852.

These shells have, in each valve, cardinal areas which are smooth or finely striated transversely, sometimes showing denticulations articulating with pits in the opposite valve. The muscular area is not limited by a ridge in front. The foramen is obsolete.

1. Stropheodonta nodulosa, *Phillips*, sp. Pl. XVI, figs. 6—10.

1841. Leptæna nodulosa, *Phillips*. Pal. Foss., p. 56, pl. xxiv, fig. 94.
1854. Strophomena piligera, *Sandberger*. Verst. Rhein. Nassau, p. 36, pl. xxxiv, fig. 10.
?1859. Strophodonta planolata, *Hall*. Pal. N. Y., vol. iii, p. 184, pl. xvi, figs. 9—12.
1882. Strophomena rhomboidalis, var. nodulosa, *Davidson*. Brit. Foss. Brach., vol. v, pt. 1, p. 52, pl. iii, fig. 15.

Localities.—From Lummaton twenty-six specimens are in my Collection; and from Wolborough one in my Collection and three (including one figured by both Phillips and Davidson) in the Museum of Practical Geology.

Remarks.—I feel obliged in this instance to differ from Davidson, and to follow Phillips in regarding his species as distinct. All the specimens I have seen are widely different from *St. rhomboidalis*, and there is no passage between them.

It appears to me that the shell was lenticular when young, and only became geniculated when old.

In the first place, among the specimens above enumerated there are a number of flat shells, frequently much injured, but all showing the same characters. They are covered with multitudinous, minute, and very flexuous, rounded threads, which are sometimes discontinuous. In most instances, but not always, every fourth or fifth thread is rather larger than the rest. The part about the umbo is very slightly convex, and the umbo itself slightly projects beyond the hinge-line in a sharp triangular apex. The hinge-line is straight, and as long as the width of the shell. The cardinal angles are sharp, and are occasionally produced into a small acute wing. The area is narrow, oblique, and striated transversely; and there is a convex pseudo-deltidium. The inner surface of the valve is minutely pitted. In most specimens there are more or less distinct indications of rounded corrugations on the surface. These shells I take to be the young form of the species.

Secondly, we have eight larger specimens from Lummaton and Wolborough, which are steeply geniculated, and coincide with Phillips's type in every respect. These agree with the former set of specimens in character and ornament, except that the corrugations are more definite, and there can, I think, be no doubt that they are simply its adult condition.

It seems to me that this species is distinguished from *St. rhomboidalis* by the striæ being much closer and lower as well as more numerous and flexuous, by the rugæ being more numerous, more rounded, and lower, and also by other particulars more easily recognised than described. One of the specimens shows that the internal arrangements are different.

With the young form of this species *Strophеodonta planolata*, Hall, seems in close agreement, showing in some specimens the same variation in the ribs. *Strophеodonta perplana*, Hall,[1] is also very similar in general appearance, and at least in some characters.

St. piligera, Sandberger, also seems from its figures to agree with the young or lenticular form of our shell, except that the rays are rectilinear. It is described as geniculate in its adult state. The muscular impressions on the upper valve seem, however, to be larger.

2. Strophеodonta irregularis, *F. Römer*, sp. Pl. XVII, fig. 1.

1844. Leptæna irregularis, *F. Römer*. Rhein. Uebergangsgeb., p. 75, pl. iv, fig. 1.
1884. Strophomena irregularis, *Davidson*. Brit. Foss. Brach., vol. v, p. 285, pl. xx, fig. 23.
1885. — — *Maurer*. Abhandl. Grossh. Hessisch. Geol. Landes., vol. i, pt. 2, p. 145, pl. v, figs. 18—20.

Remarks.—There is one specimen in my Collection from Wolborough which shows the constant divarication of the ribs which is indicated in Römer's figure. Mr. Champernowne's fossil is the only one I know from Lummaton.

3. Strophеodonta interstrialis, *Phillips*, sp. Pl. XVII, figs. 3, 4.

1841. Orthis interstrialis, *Phillips*. Pal. Foss., p. 61, pl. xxv, fig. 103.
?1843. Strophomena varistriata, *Conrad*. Journ. Acad. Nat. Sci. Phil., vol. viii, p. 255, pl. xiv, fig. 6.
1854. — zigzag, *Sandberger*. Verst. Rhein. Nassau, p. 365, pl. xxxiv, fig. 7.
?1859. — varistriata, *Hall*. Pal. N. Y., vol. iii, p. 180, figs. 1—8, 16.

[1] 1867, Hall, 'Pal. N. Y.,' vol. iv, pt. 1, p. 92, pls. xi, xii, xvii, xix, *passim*.

1865. LEPTÆNA INTERSTRIALIS, *Davidson*. Brit. Foss. Brach., vol. iii, pt. 6, p. 85, pl. xviii, figs. 15—18.
1867. — PLANA, *Trenkner*. Palæont. Novit., pt. 1, p. 19, pl. iii, fig. 40.
1867. — AFFINIS, *Trenkner*. Ibid., p. 20, pl. iii, fig. 41.
1867. STROPHOMENA RADIATA, *Trenkner*. Ibid., p. 21, p. iii, fig. 44.
1868. LEPTÆNA INTERSTRIALIS, *Dames*. Zeitsch. Deutsch. Geol. Gesell., vol. xx, p. 499, pl. xi, fig. 3.
?1874. STROPHOMENA VARISTRIATA, *Billings*. Pal. Foss., vol. ii, pt. 1, p. 26, pl. iii, fig. 3.
1884. — INTERSTRIALIS, *Clarke*. Neues Jahrb. f. Min., Beil.-Band iii, p. 400.
1885. — af. CORRUGATELLA, *Waldschmidt*. Dev. Schichts. Wildungen, p. 907, pl. xxxix, fig. 1.
1885. — INTERSTRIALIS, *Maurer*. Abhandl. Grossh. Hessisch. Geol. Landes, vol. i, pt. 2, p. 144, pl. v, figs. 17, 17 *a*.
1887. — — *Tschernyschew*. Mém. Com. Géol., vol. iii, No. 3, p. 107, pl. xiv, fig. 19.
1890. LEPTÆNA INTERSTRIALIS, *Œhlert*. Bull. Soc. Géol. Fr., ser. 3, vol. xvii, p. 776, pl. xix, fig. 10.
1892. STROPHEODONTA INTERSTRIALIS. *Whiteaves*. Contrib. Canad. Palæont. vol. i, pt. 4, p. 286, pl. xxxvii, fig. 6.

Localities.—From Lummaton there are about fifty specimens in my Collection, seventeen in the Woodwardian Museum, one in the Museum of Practical Geology, and twenty (?) in the Torquay Museum. From Barton there are six (including three which were figured by Phillips) in the British Museum. From Wolborough there is one specimen in Mr. Vicary's Collection.

Remarks.—This species shows a greater amount of variation than is indicated by Davidson. Some of the smallest specimens are either flat or geniculated, and have a few fine rays sunk in hollows between slightly convex interspaces, which are covered by minute radiations and strong transverse puckerings. As the shell increases in size the ventral valve becomes evenly convex, the major rays become stronger and more numerous, and at last form high indefinite ridges, while the interspaces become concave, and the puckerings usually, but not always, vanish, so that the fine secondary radiation alone remains. In this stage it is distinguished from small specimens of *L. nobilis* chiefly by its fewer and coarser ribs, and by the absence of puckerings, at least on the marginal parts. In other examples the minor rays seem obliterated, the interspaces between the major ribs being either concave or convex, and themselves ornamented by a few coarse ribs. Thus it is seen that the variations are not constant with the size, but at the same time the gradations are so perfect that there is no doubt that the shells all belong to one species.

It still seems an open question whether it is distinct from *L. nobilis*. The

chief arguments in favour of this are the great difference in size and the absence of specimens of intermediate dimensions, and also the fact that the variations in its ornament are not, on the whole, in such a direction as to make it probable that, if a specimen were assumed to grow to the size that *L. nobilis* constantly reaches, its ornament would, in that case, be at all similar.

Another species which is not always easy to distinguish from it is *Strophcodonta nodulosa*, Phillips, sp.; for, while the two shells are typically very different, some flattish specimens with fine major ribs are not very dissimilar.

The shell which Waldschmidt refers to *St. corrugatella* belongs clearly, I think, to this species, and it seems to me not impossible that the Llandeilo *St. corrugatella*, Davidson, may itself prove specifically identical.

Billings' figure of the American *St. varistriata* seems identical with the English shell, but Hall's figures are not quite so like. I should think that it was probably only a local variety. Billings remarks that it perfectly agrees with *St. inæquiradiata*[1] except in size. The latter shell, however, is distinguished from the present by having very much more numerous ribs.

Strophomena interstrialis, Barrois,[2] seems a much larger, longer, and flatter shell, so that I doubt its identity with the present species, and think that it agrees with *St. tæniolata*, Sandberger.[3]

Whiteaves regards it as certainly belonging to the sub-genus *Strophcodonta*. I had independently come to the same conclusion.

4. Strophcodonta? nobilis, *M'Coy*, sp.

1852. Leptæna nobilis, *M'Coy*. Brit. Pal. Foss., p. 386, pl. ii A, fig. 8.
1865. — (?) — *Davidson*. Brit. Foss. Brach., vol. iii, pt. 6, p. 86, pl. xviii, figs. 19—21.
1882. — — *Davidson*. Ibid., vol. v, pt. 1, p. 53.
? 1882. Strophomena nobilis? *Barrois*. Mém. Soc. Géol. Nord, vol. ii, p. 242.

Localities.—From Lummaton there are thirteen specimens in my Collection. From Wolborough there are three specimens in Mr. Vicary's Collection, and three in the British Museum.

Remarks.—As remarked by Davidson, this species is very closely allied to *Strophcodonta interstrialis*. The chief distinctions are the very great difference

[1] 1867, Hall, 'Pal. N. Y.,' vol. iv, p. 87, pl. xi. figs. 24—31; pl. xii, fig. 12; and pl. xiii, figs. 6—11.

[2] 1882, Barrois, 'Mém. Soc. Géol. Nord,' vol. ii, p. 243, pl. ix, figs. 8 *a*, *b*; and 1889, ibid., vol. iii, p. 64, pl. iv, fig. 8.

[3] 1854, Sandberger, 'Verst. Rhein. Nassau,' p. 360, pl. xxxiv, figs. 11 *a—d*.

in size, and the much larger number of major radiating ribs. I should be inclined to class them together, but that I have met with no intermediate specimens whatever, though neither form is rare.

The hinge-area of the ventral valve seems marked by fine oblique lines, and that of the dorsal valve by numerous short, perpendicular, tooth-like ridges. It is to be noted that the transverse rugæ are frequently more pronounced than is indicated by Davidson's figures.

Stropheodonta Patersoni, Hall,[1] is marked with similar wrinkles, and has intermediate radiations, but differs in other respects.

VIII. *Family.*—Productidæ, *King*, 1846.

1. *Genus.*—Productella, *Hall*, 1867.

Hall has separated under this name the Devonian species of *Productus* as having cardinal areas and articular processes of the valves. *P. subaculeata* was taken as the type of the genus. It is regarded as a genus or sub-genus by Œhlert and by Zittel, but it was not adopted by Davidson. I have not myself been able to form any independent opinion on the question.

1. Productella subaculeata, *Murchison*, sp.

1840. Productus subaculeatus, *Murchison*. Bull. Soc. Géol. Fr., vol. xi, p. 255, pl. ii, fig. 9.
1840. Leptæna fragaria, *Sowerby*. Geol. Trans., ser. 2, vol. v, pt. 3, pl. lvi, fig. 5 (only).
1865. Productus subaculeatus, *Davidson*. Brit. Foss. Brach., vol. iii, pt. 6, p. 99, pl. xx, figs. 1, 2.
1867. Productella subaculeata ? *Hall*. Pal. N. Y., vol. iv, pt. 1, p. 154, pl. xxiii, figs. 4, 5.
? 1867. — spinulicosta. Ibid., p. 160, pl. xxiii, figs. 25—34.
1867. — Shumardiana. Ibid., p. 157, pl. xxiii, figs. 6—8, 35—37.
? 1867. — truncata. Ibid., p. 160, pl. xxiii, figs. 12—24.
1883. Productus subaculeatus, *Kayser*. In Richtofen's China, vol. iv, p. 93, pl. xiii, fig. 5.

[1] 1867, Hall, 'Pal. N. Y.,' vol. iv, pt. 1, p. 89, pl.. xiii, figs. 1—5.

1885. PRODUCTUS SUBACULEATUS, *Maurer*. Abhandl. Grossh. Hessisch. Geol. Landes, vol. i, pt. 2, p. 132, pl. v, fig. 1.
1886. — — *Wenjukoff*. Fauna Dev. Syst. N.W., und Central Russl., p. 457, pl. ii, fig. 7.
1891. PRODUCTELLA SPINULICOSTA, *Whiteaves*. Contrib. Canad. Pal., vol. i, pt. 3, p. 217, pl. xxix, figs. 3, 3 *a*, and pl. xxxi, fig. 1.
1891. — SUBACULEATA, var. CATARACTA, *Whiteaves*. Ibid., p. 217.
1892. — — *Whiteaves*. Contrib. Canad. Pal., vol. i, pt. 4, p. 283.

Localities.—There are about thirty specimens in my Collection, and three in the Woodwardian Museum, from Lummaton, and about ten in the Torquay Museum, probably from the same locality. From Wolborough there are fourteen fine specimens in Mr. Vicary's Collection, one in mine, three in the Museum of Practical Geology, three in the British Museum, and one in the Bristol Museum.

Remarks.—This seems a very variable species, both as to width, convexity, and the number of its tubercles. The side of the shell under the hinge seems frequently, but not always, swollen into a kind of wing. The largest specimens are generally the most transverse, young shells being sub-orbicular, and frequently as convex as the full-grown shells. The tubercles are small and often few upon the younger shells. The beak sometimes is very depressed, and sometimes overhangs the hinge.

There are several small American shells which are very difficult to distinguish from small forms of the present species. *P. spinulicosta* may perhaps be separated by its strong concentric ridges, and may come nearer to *Strophalosia productoides*. *P. truncata* seems only separable by its small size and constant attachment by the substance of the beak. It may perhaps really be the fry of a larger species, especially as it is described as gregarious.

The shell given by Whiteaves as *P. spinulicosta* seems to me exactly like the Devonshire form.

2. PRODUCTELLA FRAGARINA, n. sp. Pl. XVII, figs. 10, 11, 11 *a*, 11 *b*.

1840. LEPTÆNA FRAGARIA (young ?), *Sowerby*. Geol. Trans., ser. 2, vol. v, pt. 3, pl. lvi, fig. 6 (only).
1865. STROPHALOSIA PRODUCTOIDES, *Davidson* (pars). Brit. Foss. Brach., vol. iii, p. 97, pl. xix, figs. 17—17 *c* (only).

Description.—Shell convex, rather longer than wide. Ventral valve convex in the centre, spreading out flatly on the wings. Beak prominent, rounded, narrow

behind, steep laterally, and overhanging the hinge. Hinge-line apparently shorter than the greatest width of the shell, which occurs at about two-thirds the way down from the hinge to the front margin. Front margin moderately and evenly convex. Surface covered with large close tubercles, bearing spines and arching out in excentric concave lines from the umbo to the margins. Dorsal valve deeply concave (except on the sides near the hinge, which are flat), marked with large pits, which correspond to the tubercles on the other valve, and are divided by narrow prominences.

Size.—Length, 25 mm.; width, 25 mm.; depth, 9 mm.

Localities.—There are seventeen specimens in my Collection, four in the Torquay Museum, and three in the Woodwardian Museum, from Lummaton, and two in the Museum of Practical Geology from Newton. Sowerby figures it from Plymouth, and Davidson from East Ogwell.

Remarks.—A small specimen of this species was figured by Sowerby with the remark that it was "probably the young of *Leptæna fragaria* (*i. e. P. subaculeata*); the tubercles are more numerous in proportion to the size." It is, however, clearly distinct from that shell. My specimens vary in size, but never attain the dimensions of the full-grown *P. subaculeata*. They are also distinguished from it by the closeness, size, and regularity of the tubercles, the greater length of the shell, and the narrowness and prominence of the umbonal parts of the ventral valve. They also differ from its young forms, which are characterised by very slight tuberculation and very indefinite and broadly rounded umbones, thus preserving the characters of the full-grown shell. These differences are constant, and are too great to allow it to be regarded as a variety of that species, though some rather doubtful specimens may occur.

Davidson figured a full-sized specimen under the name of *Strophalosia productoides* from East Ogwell, but he does not quote Sowerby's figure in his list of synonyms. It certainly seems to me that it cannot be the same as that species, as it differs greatly in the size, number, and character of its tubercles, its greater length, and other particulars. I therefore am obliged to regard it as a separate species, and I know no foreign shell which approaches it.

As it is only on the strength of these specimens that *St. productoides* has been included in the list of Lummaton fossils, that shell must consequently be removed therefrom. It occurs, however, in the "Pleurodictyum-beds" at Meadfoot.

3. Productella, sp. Pl. XVII, figs. 12, 12 *a*.

Description.—Ventral valve evenly convex, transverse, semi-oval. Beak small, not extending above hinge-line, depressed. Hinge-margin as wide as the shell.

Wings small, flat, triangular. Surface covered with very fine, close, rounded, and regular microscopic radiating striæ, crossed by rather numerous sub-equal and regular growth-lines, which become nodulous on the hinge-margin, and with which rows of numerous small, low, elongate, triangular tubercles more or less correspond.

Size.—Length, 23 mm.; width, 26 mm.; depth, 6 mm.

Locality.—There is a single specimen in my Collection from Lummaton.

Remarks.—This shell differs from *P. subaculeata* in the possession of fine radiating lines, in the size and character of its tubercles, and in several other particulars. It seems to differ from any Devonian or Carboniferous species. From *Productus pustulosus*, Phillips,[1] and *P. spinulosus*, Sowerby,[2] it seems distinguished by its smaller umbo and by the presence of radiations. *Marginifera? Spitzbergiana*, Toula, as given by Tschernyschew,[3] has a larger umbo.

2. *Genus.*—Chonetes, *Fischer*, 1837.

1. Chonetes Hardrensis, *Phillips*, sp. ? Pl. XVII, figs. 13, 13 *a*.

1841. Orthis Hardrensis, *Phillips*. Pal. Foss., p. 138, pl. lviii, figs. 104*, *a*—*d*, and pl. lx, fig. 104*.

1865. Chonetes Hardrensis (pars), *Davidson*. Brit. Foss. Brach., vol. iii, pt. 6, p. 95, pl. xix, figs. 4—8 (only).

? 1892. — Manitobensis, *Whiteaves*. Contrib. Canad. Palæont., vol. i, pt. 4, p. 281, pl. xxxvii, figs. 1—2.

Remarks.—Davidson gives this species in his list of Lummaton fossils. I have obtained from that locality a single imperfect specimen, which closely agrees with Phillips's figure and description except that the rays are much more numerous. It is covered by fine, close, rounded, regular, concentric threads, after the manner of *Chonetes Phillipsii*; but it shows no signs of spines, except on the hinge, where there appear to have been only two or three marginal spines set obliquely, and in this point it differs from *Ch. tenuicostatus*, Œhlert,[4] which in other respects it seems greatly to resemble.

A comparison of specimens makes me think it distinct from the species of *Chonetes* which are so common in the Pilton beds of North Devon and in the

[1] 1861, Davidson, 'Brit. Foss. Brach.,' vol. ii, p. 168, pl. xli, figs. 1—6, and pl. xlii, figs. 1—4

[2] 1861, Davidson, ibid., p. 175, pl. xxxiv, figs. 18—21.

[3] 1889, Tschernyschew, 'Mém. Com. Géol.,' vol. v, pt. iv, p. 286, pl. vii, fig. 36.

[4] 1883, 'Bull. Soc. Géol. Fr.,' ser. 3, pl. xi, p. 515; pl. iv, figs. 2—2 *d*.

Carboniferous Rocks; but I am not yet sure that it ought to bear Phillips's name in contradistinction to them.

I see no difference between my specimen and *Ch. Manitobensis*, Whiteaves; neither of them shows signs of any spines on the surface of the valves. Whiteaves regards his species as a variety of the Silurian *C. striatellus*, Dalman, sp.,[1] which is, however, a wider shell than ours.

Ch. setiger, Hall,[2] and *Ch. Logani*, Norwood and Pratten,[3] are similarly marked, but have fewer rays.

2. Chonetes? Phillipsii, *Davidson*.

1882. Chonetes? Phillipsii, *Davidson*. Brit. Foss. Brach., vol. v, pt. 1, p. 54, pl. iii, figs. 23, 23 *a*.

Localities.—From Lummaton there are four specimens in my Collection, and two, apparently from the same locality, in the Torquay Museum.

Remarks.—I have nothing new to add about this species.

It seems to differ from *Chonetes minutus*, Goldfuss, MS.,[4] in being more angular and in having a stronger concentric ornamentation.

3. Chonetes convolutus, *Phillips*, sp.?

1841. Leptæna convoluta, *Phillips*. Pal. Foss., p. 57, pl. xxiv, fig. 96.
1865. Chonetes Hardrensis (pars), *Davidson*. Brit. Foss. Brach., vol. iii, pt. 6, p. 94, pl. xix, fig. 9 (only).
1882. — convolutus, *Davidson*. Ibid., vol. v, pt. 1, p. 55.

Locality.—There are seven specimens from Lummaton in my Collection.

Remarks.—These shells appear to agree accurately with Phillips's figure of *L. convoluta*, but I am by no means certain that they are anything more than the lower valves of the species described as *Ch. Phillipsii* by Davidson. They differ from it in having a less prominent beak, which does not overhang the hinge-margin, in their shape being more triangular, and in there being little or no sign of the beautiful transverse ornamentation seen in that species. My specimens are not, however, in a sufficiently good state of preservation to settle the point. If they are identical, the question still remains whether Phillips's Croyde Bay fossils are

[1] 1870, Davidson, 'Brit. Foss. Brach.,' vol. iii, pt. 7, p. 332, pl. xxxix, figs. 23—26.
[2] 1867, Hall, 'Pal. N. Y.,' vol. iv, p. 129, pl. xxi, figs. 2 *a*, *b*, and pl. xxii, figs. 1—5.
[3] Ibid., p. 137, pl. xxii, figs. 16—28.
[4] 1865, Davidson, 'Brit. Foss. Brach.,' vol. iii, pt. 6, p. 96, pl. xix, figs. 10—12.

really the same. In that case *Ch. Phillipsii* would become a synonym of *Ch. convolutus;* but it is certainly distinct from *Ch. Hardrensis*, with which *Ch. convolutus* was formerly united by Davidson. Under the circumstances it seems best to retain the name for the present upon the Lummaton list.

2. Order.—INARTICULATA, *Deshayes*, 1836.

I. *Family.*—Discinidæ, *Gray*, 1848.

1. *Genus.*—Discina, *Lamark*, 1819.

1. Discina peltastes, n. sp. Pl. XVII, fig. 14.

Description.—Ventral or pedicle valve rather large, slightly conical, elongate oval, apparently rather steeper and narrower behind. Apex posteriorly sub-central. Sulcus unknown. Internal pedicle-area apparently minute and elongate, with the lateral callosities coalesced to form a small tube with a minute foramen, only produced a little in front of the centre of the shell. Surface ornamented with numerous very fine and rather irregular concentric threads, separated by wider interspaces. Shell-structure very thin.

Size.—Length, 22 mm.; width, 16 mm.

Locality.—A single specimen is in my Collection from Lummaton.

Remarks.—This shell is widely different from the *Orbiculoidea* (*Discina*) *nitida*, Phillips,[1] described from North Devon. It seems characterised by its comparatively large size, its elongate form, and its numerous fine concentric lineations. The only specimen I know is rather obscure, being defective and obliquely compressed. It lies in the matrix with the inner surface exposed, but the character of the surface-ornament is sufficiently apparent, except where covered by callosities.

Rather below the centre is a minute tube, which seems to me to be undoubtedly the internal opening of the pedicle-groove. This appears to be accidentally fractured above, the actual foramen opening downwards. If this is so, the arrangement seems to indicate that it belongs to the genus *Discina* as restricted by Dall[2] and Hall[3] to the recent group of *Discina striata*, Schumacker, sp.[4] (not Sowerby), rather than to *Orbiculoidea*, &c., to which Hall refers the Palæozoic *Discinæ* gener-

[1] 1865, Davidson, 'Brit. Foss. Brach.,' vol. iii, pt. 6, p. 104, pl. xx, figs. 9, 10.
[2] 1871, Dall, 'Bull. Mus. Comp. Zool. Harvard College,' vol. iii, pt. 1, p. 39.
[3] 1892, Hall, 'Pal. N. Y.,' vol. viii, pt. 1, p. 122, pl. iv K, figs. 23, 24.
[4] 1817, Schumacher, 'Essai Nouv. Syst. Vers Test.,' p. 102, pl. xx, figs. 1 *a—f*.

ally. This portion of the shell is, unfortunately, very obscure, and it does not seem to lie quite symmetrically, which, however, may possibly be due to crushing.

Affinities.—*Discina anomala*, Kayser,[1] is somewhat similar in shape, but is larger and ornamented with fine rays.

II. *Family.*—Craniidæ, *d'Orbigny*, 1847.

1. *Genus.*—Crania, *Retzius*, 1781.

1. Crania proavia, *Goldfuss?* Pl. XVIII, fig. 1.

1840.	Crania proavia,		*Goldfuss.*	Petref. Germ., vol. ii, p. 298, pl. clxiii, figs. 10 *a*, *b*.
1854.	—	—	*Schnur.*	Palæontographica, vol. iii, p. 230, pl. xliii, figs. 9 *a*, *b*.
1871.	—	—	? *Kayser.*	Zeitsch. Deutsch. Geol. Gesell., vol. xxiii, p. 641, pl. xiv, fig. 6.

Locality.—A single small specimen attached to a shell of *Pentamerus brevirostris* from Lummaton is in my Collection.

Remarks.—This little fossil is clearly a *Crania*, but it is too imperfect for me to say more than that it accurately corresponds with Goldfuss's species as far as its characters are seen, except in size. It is less than 4 mm. in diameter, slightly wider than long, subquadrate in shape, and flatly conical in contour, being much steeper behind. The shell is removed from the central parts of the upper or free valve, exposing two adjacent kidney-shaped impressions of the anterior adductors, which are situate at about the posterior third of the longitudinal diameter and immediately in front of the apex. The surface of the cast is minutely granulose, and seems bounded by one or two strong marginal furrows. The shell-structure is rather thick for the size of the shell, and appears to have borne a lamellose concentric ornament.

[1] 1892, Kayser, 'Jahrbuch Königl. Preuss. Geol. Landes,' p. 97, pl. x, figs. 1—3.

PLATE XI.

All the figures on this Plate are from specimens from Lummaton in my Collection.

MAGELLANIA WHIDBORNEI, *Davidson*, sp. (Page 91.)

FIG.

1. Dorsal view of a large specimen, defective at the beak, enlarged. 1 *a*, portion of surface, × 25.

MAGELLANIA, ? sp. (Page 92.)

2. Dorsal view of a specimen, enlarged, showing the low rounded ribs. 2 *a*, lateral view. 2 *b*, portion of surface, × 25.

MAGELLANIA JUVENIS, *Sowerby*, sp. (Page 93.)

3. Dorsal view of a very large specimen, whose foramen is hidden by the matrix. 3 *a*, lateral view.

CENTRONELLA VIRGO, *Phillips*, sp. (Page 94.)

4. Dorsal view of a specimen, enlarged, showing ribs in front. 4 *a*, lateral view. 4 *b*, portion of surface, × 25.

N.B.—In 4 *b* I have not myself observed the definite ridges, but the artist states that he has carefully copied the shell. In any case the figure is askew. It should be turned backwards through an angle of 45°, so that its left-hand corner would become the top, and then it would represent a portion of the left side of the shell, and give some idea of the elegantly arching system of puncta. Similarly 1 *a* and 2 *a* represent the artist's views, and not my own.

ENANTIOSPHEN VICARYI, *Davidson*, sp. (Page 97.)

5. Dorsal view of an elongate specimen, showing the beak. 5 *a*, lateral view.
6. Dorsal view of a very wide specimen; fragments of shell having been removed from the apex of each valve show the beginning of the internal septa; the coarse prismatic structure of the shell-substance, where somewhat decorticated, is also seen. This specimen is deep, and, when viewed laterally, it closely resembles fig. 5 *a*.
7. Fragment of the beak of a specimen seen laterally from within, and showing on the left the flat septum, to which is attached the convex dental plate which is seen on the right.

ENANTIOSPHEN ŒHLERTII, nov. var. (or n. sp.). (Page 98.)

8. Dorsal view of a very large specimen, perhaps only a variety of *E. Vicaryi*, having no marginal inflation. A portion of shell removed from the apex of the dorsal valve has exposed the beginning of the internal septal plate. 8 *a*, ventral view showing the prismatic structure of the shell where worn, and the transverse ridges where the surface is perfectly preserved. 8 *b*, lateral view showing the sharp margins of the area in both valves, and the transverse lineations.

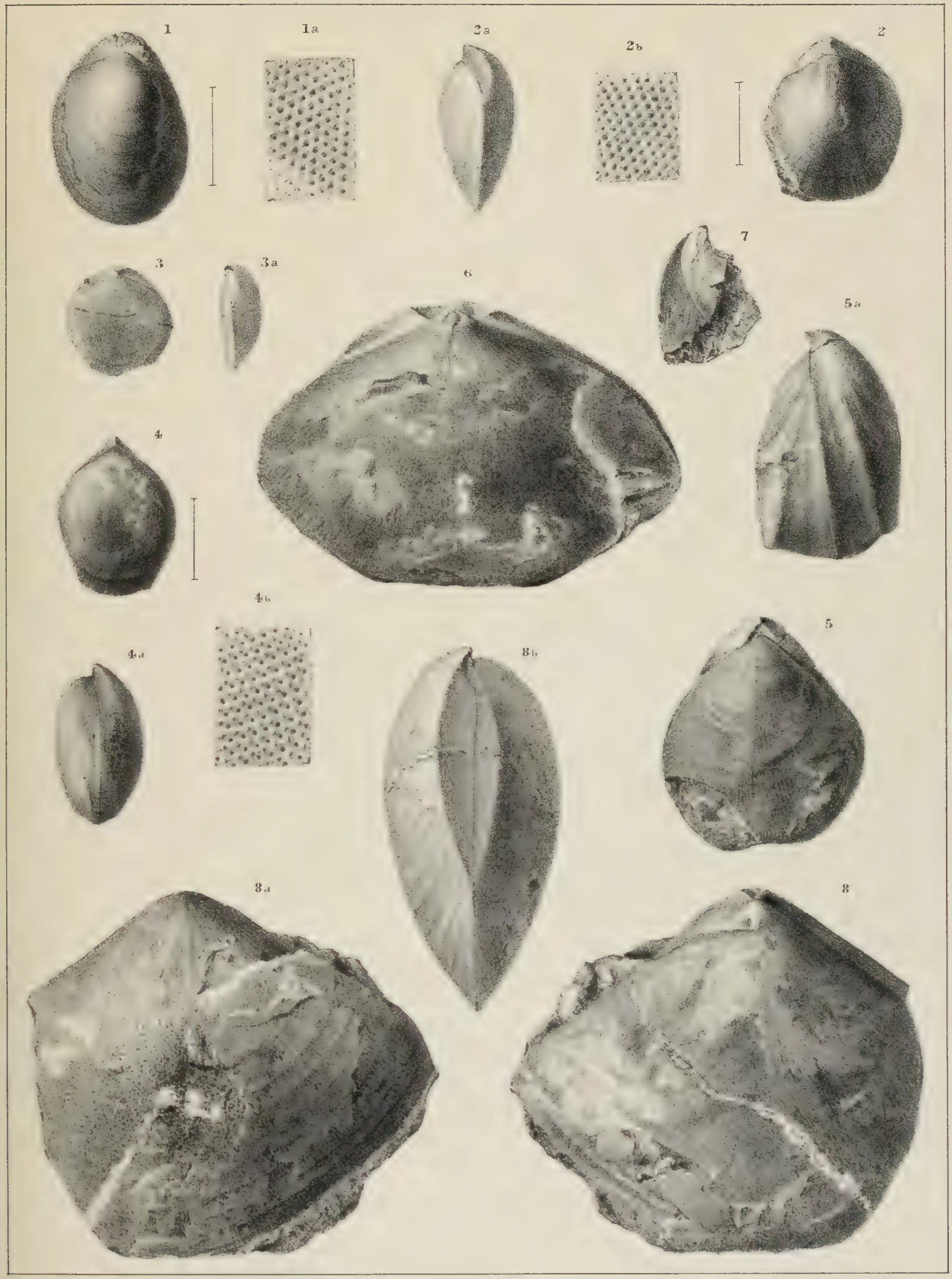

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PLATE XII.

All the figures on this Plate are from specimens from Lummaton in my Collection.

MEGANTERIS INORNATA, *d'Orbigny*, sp. ? (Page 95.)

FIG.

1. Ventral view of a large but rather crushed specimen, showing muscular impressions near the beak. 1 *a*, dorsal view of the beak. 1 *b*, lateral view, showing the entire or almost entire absence of an area.

STRINGOCEPHALUS BURTINI, *Defrance*. (Page 96.)

2. Dorsal view of the smallest specimen I have seen, enlarged. 2 *a*, portion of surface, × 10.

MERISTA PLEBEIA, *Sowerby*, sp. (Page 98.)

3. Dorsal view of a very large but distorted specimen, enlarged, showing the lines left by the edges of the internal septa. 3 *a*, lateral view.
4. Dorsal view of another specimen, enlarged, in which a portion of shell near the apex of the dorsal valve has fallen out, and left the central septum and the two lateral arching plates exposed. 4 *a*, outline of front view.
5. Natural section of another specimen, enlarged, showing one of the septa of the shoe-lifter process and the attached dental plate, and also the beginning of one of the spiral arms.

MERISTA PLEBEIA, var. LACRYMA, *Sowerby*, sp. (Page 99.)

6. Dorsal view of a specimen, enlarged. 6 *a*, front view, showing the biplicated fold.

BIFIDA ? PLANA, n. sp. (Page 102.)

8. Dorsal view of a specimen, showing median depression, enlarged. 8 *a*, lateral view. 8 *b*, diagram of beak magnified.

GLASSIA WHIDBORNEI, *Davidson*. (Page 114.)

7. Dorsal view of a flat specimen, showing growth-lines, enlarged. 7 *a*, lateral view.
9. Dorsal view of a deeper specimen, enlarged. 9 *a*, lateral view. 9 *b*, beak, more enlarged.

CYRTINA HETEROCLITA, var. DEMARLII, *Davidson*. (Page 113.)

10. Dorsal view of a specimen in which the central fold is bifid, but the plaits few and irregular as in Defrance's shell.

CYRTINA HETEROCLITA, *Defrance*, sp. (Page 111.)

11. Dorsal view of a specimen in which the central fold is simple above and trifid near the margin, enlarged.
12. Oblique ventral view of another specimen which has small oblique rays running down each side of the central sinus, enlarged.

CYRTINA HETEROCLITA, var. MULTIPLICATA, *Davidson*. (Page 112.)

13. Dorsal view of the specimen said to be figured by Davidson (vol. v, pl. ii, fig. 8), enlarged. 13 *a*, side view showing the flat receding area of the ventral valve.

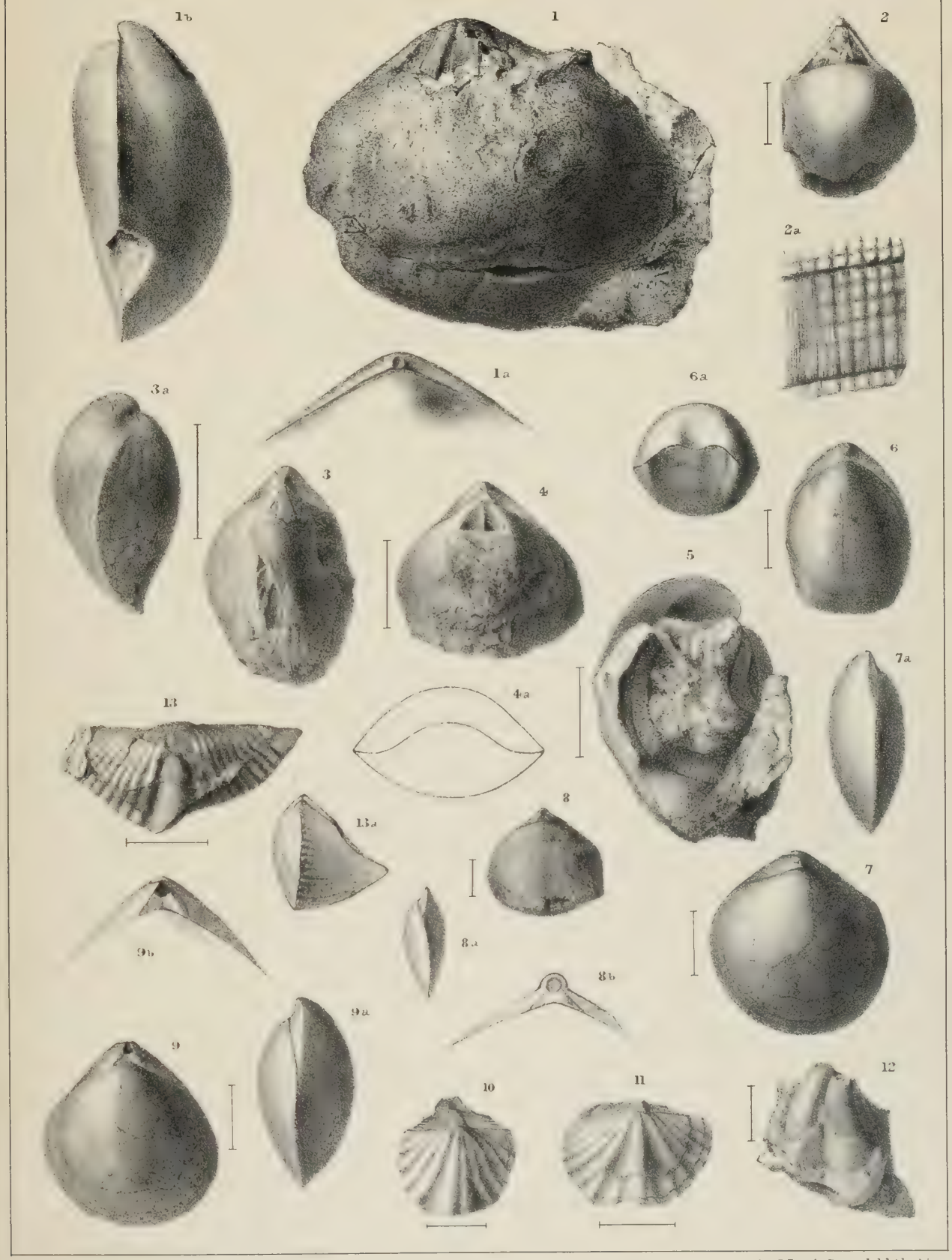

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PLATE XIII.

All the figures in this Plate are from specimens from Lummaton in my Collection, except where otherwise stated.

SPIRIFERA INFIMA, n. sp. (Page 108.)

FIG.

1. Ventral view of a specimen with no signs of a sinus on the ventral valve, enlarged. 1 *a*, lateral view, showing the depth of the beak.
2. Dorsal view of a typical specimen from this locality, showing the sharp cardinal angles and wide hinge-line, and a well-marked sinus, enlarged. 2*a*, lateral view.
3. Dorsal view of a doubtful specimen with very rounded cardinal angles and little or no signs of any sinus, enlarged. 3 *a*, lateral view.

SPIRIFERA CURVATA, *Schlotheim*, sp. (Page 107.)

4. Dorsal view of a very narrow variety with a rather curiously shaped fold, enlarged. 4 *a*, a ventral view.
5. Ventral view of a small shell of unusual shape, enlarged. 5 *a*, lateral view showing the elevated hinge-line.

SPIRIFERA UNDIFERA, *F. Römer*. (Page 105).

6. Portion of the ornament of a specimen, showing the transverse ridges composed of rows of short lineations, and the linear riblets between the larger low ribs, × 7.
7. Portion of the ornament of another specimen, in which the major ribs have vanished and the linear riblets have become more prominent, × 7.

SPIRIFERA CONCINNA, *Hall?* (Page 105.)

8. Dorsal view of a specimen retaining a portion of the surface, which is ornamented by fine unbroken rays instead of transverse ridges. 8 *a*, portion of the surface showing these riblets, × 7.

PENTAMERUS BREVIROSTRIS, *Phillips*, sp. (Page 120.)

9. Specimen with an apparent but probably accidental area, labelled by Salter "*Spirifer*, n. sp." 9 *a*, front view. Wolborough. Vicary Collection.

ATRYPA RETICULARIS, *Linné*, sp. (Page 114.)

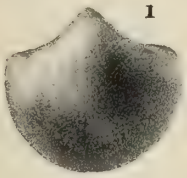
10. Specimen retaining several rows of very long fringes.

ATRYPA? TRIGONELLA, *Davidson*. (Page 118.)

11. Dorsal view of a decorticated specimen, enlarged.
12. Dorsal view of another similar specimen, enlarged.

ATRYPA DESQUAMATA, *Sowerby*. (Page 117.)

13. Dorsal view of a young shell of the variety *compressa*, × 2·5 times.
14. Dorsal view of another young shell of the same variety, but of very peculiar form, showing the dorsal sinus, enlarged. The shell being very thin, the marginal portions have been broken off. 14 *a*, side view much enlarged, showing the horizontal flatness of the foramen. 14 *b*, rear view, showing the shape of the area and the foramen, much enlarged.
15. Dorsal view of a specimen, much enlarged, showing the thickening of the margin of the foramen.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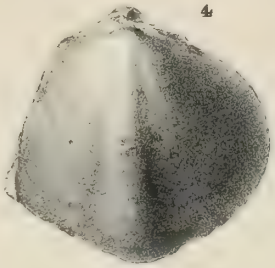
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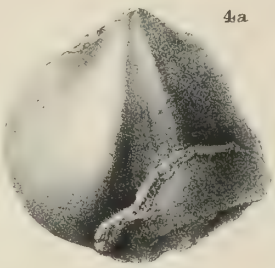
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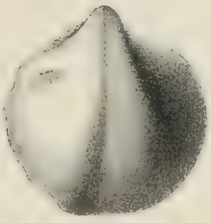
2

2a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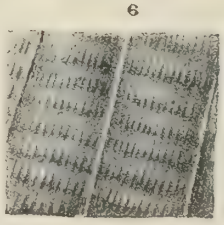
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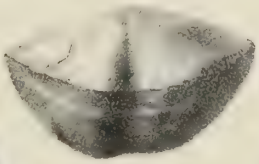
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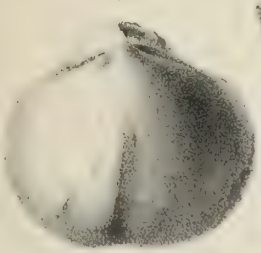
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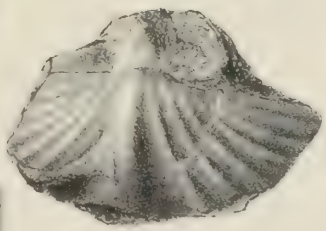
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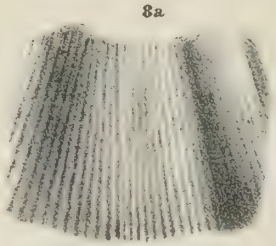
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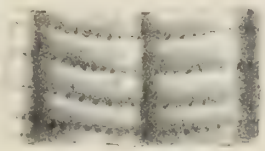
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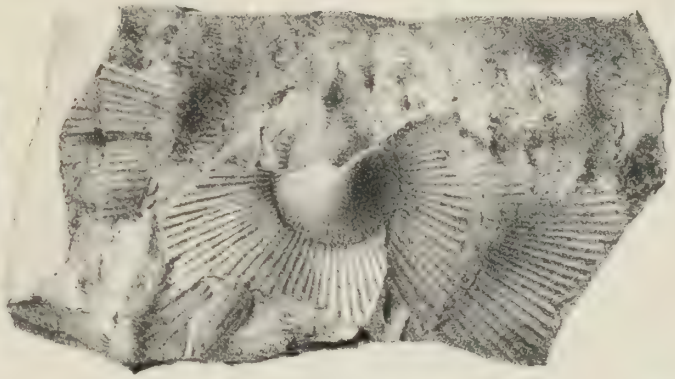
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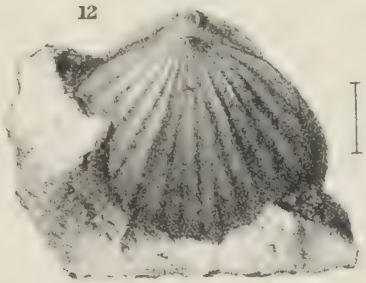
14a

13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15

14b

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PLATE XIV.

All the figures on this Plate are from specimens in my Collection from Lummaton, except where otherwise stated.

PENTAMERUS BREVIROSTRIS, *Phillips*, sp. (Page 120.)

FIG.

1. Lateral view of a very large and narrow variety. 1 *a*, front view (ventral valve uppermost).

1 *b*. Portion of surface of another similar specimen, × 5.

2. Dorsal view of a very equivalved variety. 2 *a*, front view (ventral valve uppermost). 2 *b*, lateral view.

3. Portion of surface of a specimen enlarged.

PENTAMERUS BIPLICATUS, *Schnur*. (Page 122.)

4. Lateral view of a large specimen with very sharp plaits approximating the form *P. acutolobatus*, Sandberger. 4 *a*, rear view (ventral valve below), Lummaton (?). Torquay Museum.

5. Front view of another specimen of the form *P. formosus*, Sandberger. Lummaton (?). Torquay Museum.

PENTAMERUS SUBLINGUIFER, *Maurer*. (Page 123.)

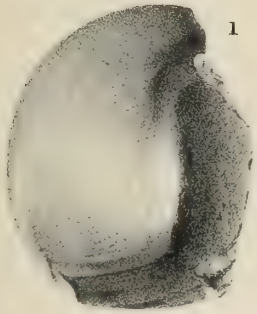
6. Dorsal view of a very large specimen. 6 *a*, lateral view. 6 *b*, front view (dorsal valve uppermost). 6 *c*, rear view.

7. Dorsal view of a very small specimen. 7 *a*, lateral view. 7 *b*, front view.

8. Dorsal view of a slightly larger specimen. 8 *a*, lateral view. 8 *b*, front view, all enlarged.

CONCHIDIUM ? BRITTANICUM, n. sp. (Page 124).

9. Ventral valve. 9 *a*, lateral view, showing the striation of the surface. 9 *b*, dorsal view, showing the apparent arrangement of the beak, all enlarged.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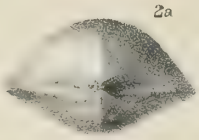
1b

1a

2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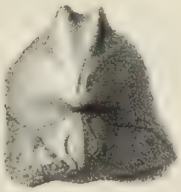
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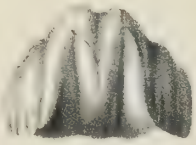
4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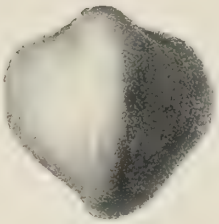
2b

6b

6a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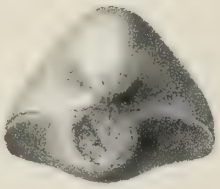
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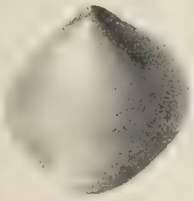
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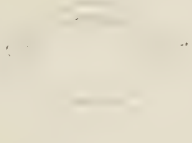
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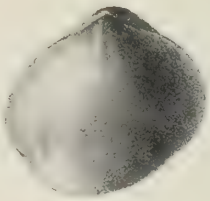
8a

8b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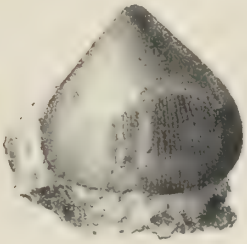
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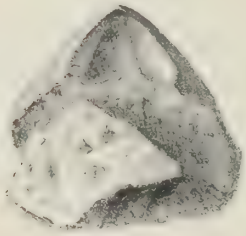
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PLATE XV.

All the figures on this Plate are from specimens from Lummaton in my Collection, except where otherwise stated.

RHYNCHONELLA? ANISODONTA, *Phillips*, sp. (Page 132.)

FIG.

1. Dorsal view of a large specimen, with its valves slightly displaced. 1 *a*, side view. 1 *b*, front view. All enlarged.
2. Portion of another specimen, much enlarged to show the finer ornament of the surface when well preserved, × 5.

RHYNCHONELLA TRILOBOIDES, n. sp. (Page 128.)

3. Dorsal view of a specimen, with broad low fold and dilated sides.

N.B.—The matrix having been cleared from the specimen since drawing, the beak is found to be higher and narrower than here represented.

RHYNCHONELLA NEAPOLITANA, n. sp. (Page 129.)

4. Dorsal view of a specimen with steep angular ribs, which reach to the apex, and are largest on the fold, and which show some degree of irregularity, enlarged. 4 *a*, side view. 4 *b*, front view. Newton. All enlarged. Museum of Practical Geology.

WILSONIA OMEGA, n. sp. (Page 135.)

5. Dorsal view of specimen of very rounded form, with ribs not reaching to the apex, and marginally bifurcated or grooved. 5 *a*, side view, showing the large ventral valve and elevated (though defective) beak, as compared with *W. cuboides*. 5 *b*, front view, showing the bifurcation or splitting of the ribs. Enlarged.

WILSONIA CUBOIDES, *Sowerby*, sp. (Page 134.)

6. Rear view of a very deep specimen enlarged. 6 *a*, lateral view.

CAMAROPHORIA ASCENDENS, *Steininger*, sp. (Page 136.)

7. Dorsal view of a transverse specimen with eight ribs on the fold, enlarged, showing the rounded ribs which reach nearly to the apex. 7 *a*, side view, with defective beak. 7 *b*, front view, showing eight ribs on the fold.
8. Dorsal view of another specimen with shorter ribs, enlarged. 8 *a*, lateral view, showing beak. 8 *b*, front view, showing five ribs on the fold.
9. Dorsal view of another specimen, with a defective beak, showing five ribs on the fold, enlarged. 9 *a*, lateral view. 9 *b*, front view, showing marginal thickening of ribs and a very deep fold. All enlarged.

RHYNCHONELLA PARALLELEPIPEDA, *Bronn*, sp. (Page 129.)

10. Dorsal view of a fine specimen, with very elevated beak. 10 *a*, lateral view.

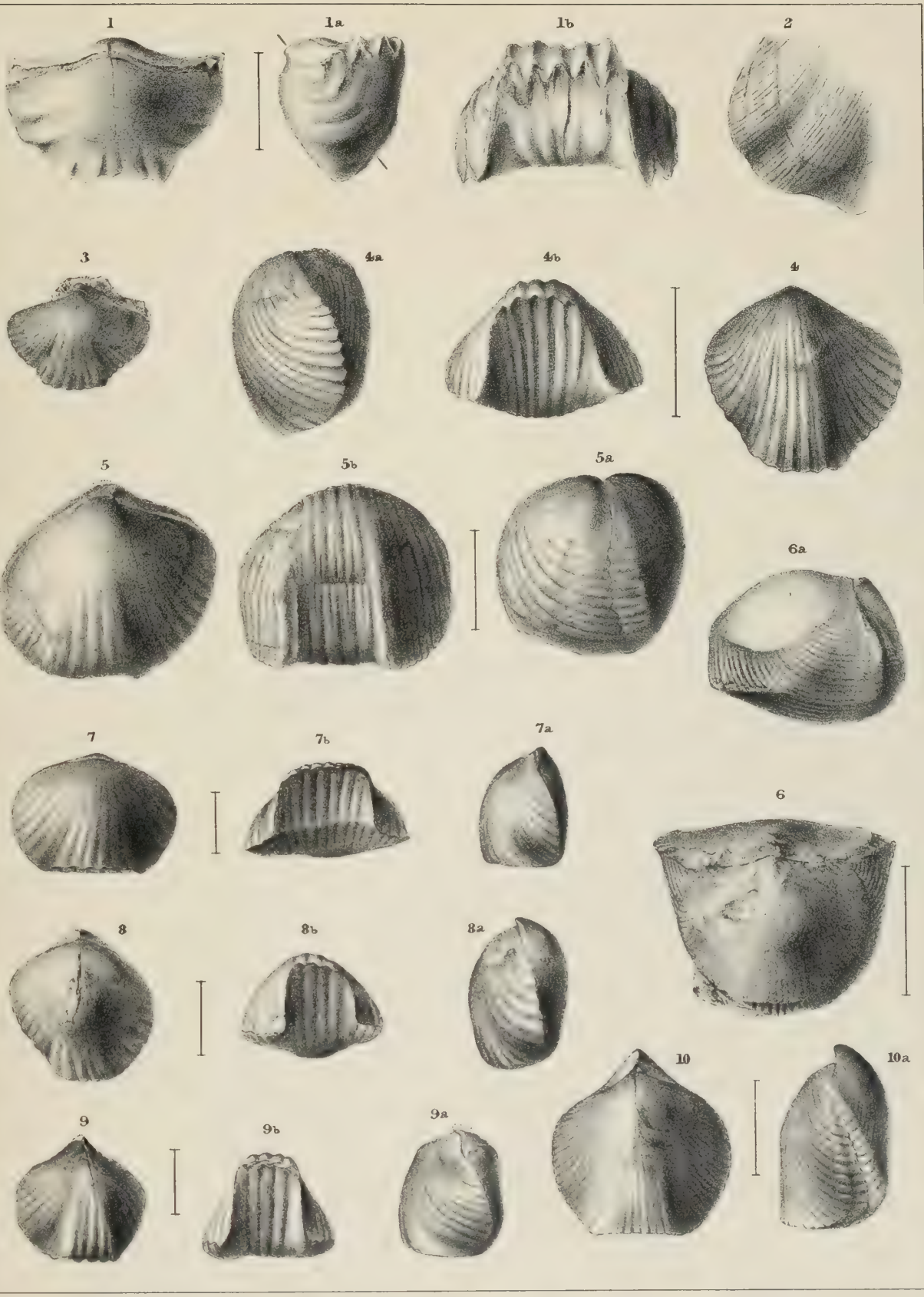

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PLATE XVI.

All the figures on this Plate are from specimens in my Collection from Lummaton.

CAMAROPHORIA PHILLIPSII, *Davidson*, sp. (Page 141.)

FIG.

1. Dorsal view of a young specimen without fold or sinus, enlarged. 1 *a*, lateral view. 1 *b*, front view.
2. Dorsal view of a very curious variety, with only two (or three) plaits on the fold, enlarged. 2 *a*, lateral view.

CAMAROPHORIA ? RHOMBOIDEA, *Phillips*, sp. (Page 140.)

3. Dorsal view of an elongate specimen, with a small deep fold, enlarged. 3 *a*, lateral view. 3 *b*, front view.
4. Dorsal view of a doubtful specimen of peculiar form, with very expanded sides, enlarged. 4 *a*, lateral view, showing the straight oblique slope of the margins.

RHYNCHONELLA ? OGWELLIENSIS, *Davidson*. (Page 133.)

5. Dorsal view of a large specimen, enlarged. 5 *a*, lateral view. 5 *b*, front view.

STROPHEODONTA NODULOSA, *Phillips*, sp. (Page 150.)

6. Upper valve of a small specimen, with many equal undulating striæ, showing some signs of geniculation, enlarged.
7. Another ungeniculated specimen, showing the acute-angled wing, enlarged.
8, 9, 10. Similar ungeniculated specimens, showing a few elevated major radiations, enlarged.

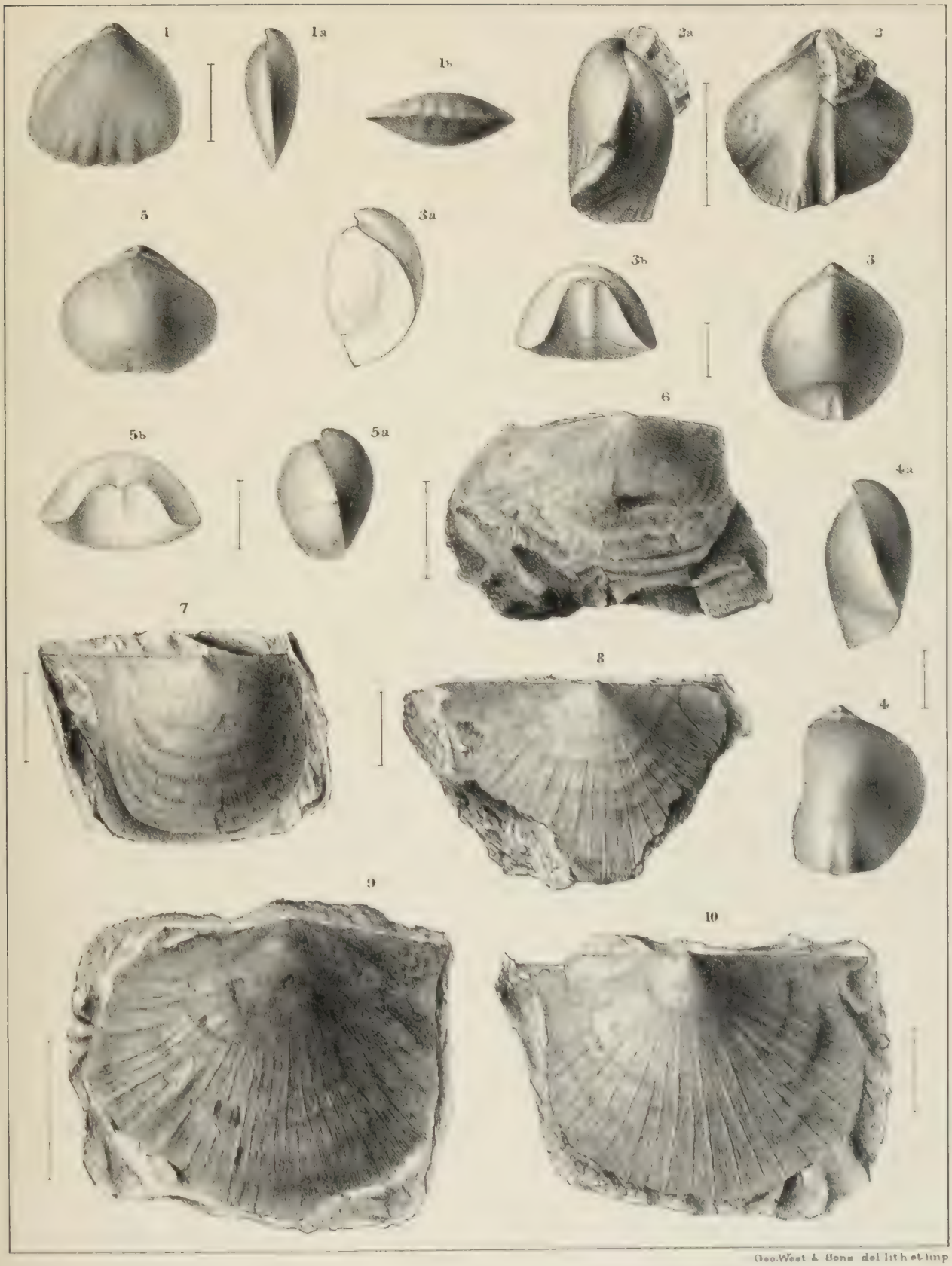

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PLATE XVII.

All the figures on this Plate are from specimens in my Collection from Lummaton, except where otherwise stated.

STROPHEODONTA IRREGULARIS, *F. Römer*, sp. (Page 151.)

FIG.

1. Ventral valve of a large specimen, which shows the irregular sinus and the frequent divarication of the ribs. Wolborough.

ORTHOTETES DISTORTUS, *Barrande*, sp. (Page 147.)

2. Ventral valve of a highly distorted specimen, enlarged.

STROPHEODONTA INTERSTRIALIS, *Phillips*, sp. (Page 151.)

3. Upper view of an extreme variety with strong corrugations, and about twelve major ribs, enlarged. (The valve is geniculated, and the minor ribs are present though too fine to be depicted.)
4. Another similar specimen with only six or seven major ribs, enlarged. (The minor ribs are clearly seen under a lens.)

N.B.—A series of many graduated specimens exist, connecting this variety with the typical form of the shell. (The rugæ are sometimes seen on much larger specimens than those figured.)

ORTHIS ? sp. (Page 144.)

5. Valve, showing the peculiar arrangement of the ribs in low convex groups, enlarged.

ORTHIS PULCHERRIMA, n. sp. (Page 145.)

6. Dorsal view of a rather injured specimen. 6 *a*, lateral view, showing the greater distance of the beak of the ventral valve. 6 *b*, rear view (ventral valve uppermost). All enlarged.

SKENEDIUM AREOLA, *Quenstedt*, sp. (Page 143.)

7. Rear view of a ventral valve with a low beak.
8. Ventral view of the large variety with numerous small ribs.

STRICKLANDINIA ? sp. (Page 125.)

9. Dorsal valve, showing the straight hinge-line, the coarse divaricating ribs, and the steep sub-angular fold, enlarged.

PRODUCTELLA FRAGARINA, n. sp. (Page 155.)

10. Ventral view of a large but imperfect specimen, enlarged. (The outline is roughly restored from a smaller but more perfect specimen.)
11. Dorsal view of another specimen, showing the pitted surface of the concave dorsal valve, enlarged. 11 *a*, ventral view, showing the regular arching lines of tubercles. 11 *b*, lateral view.

PRODUCTELLA, n. sp. (Page 156.)

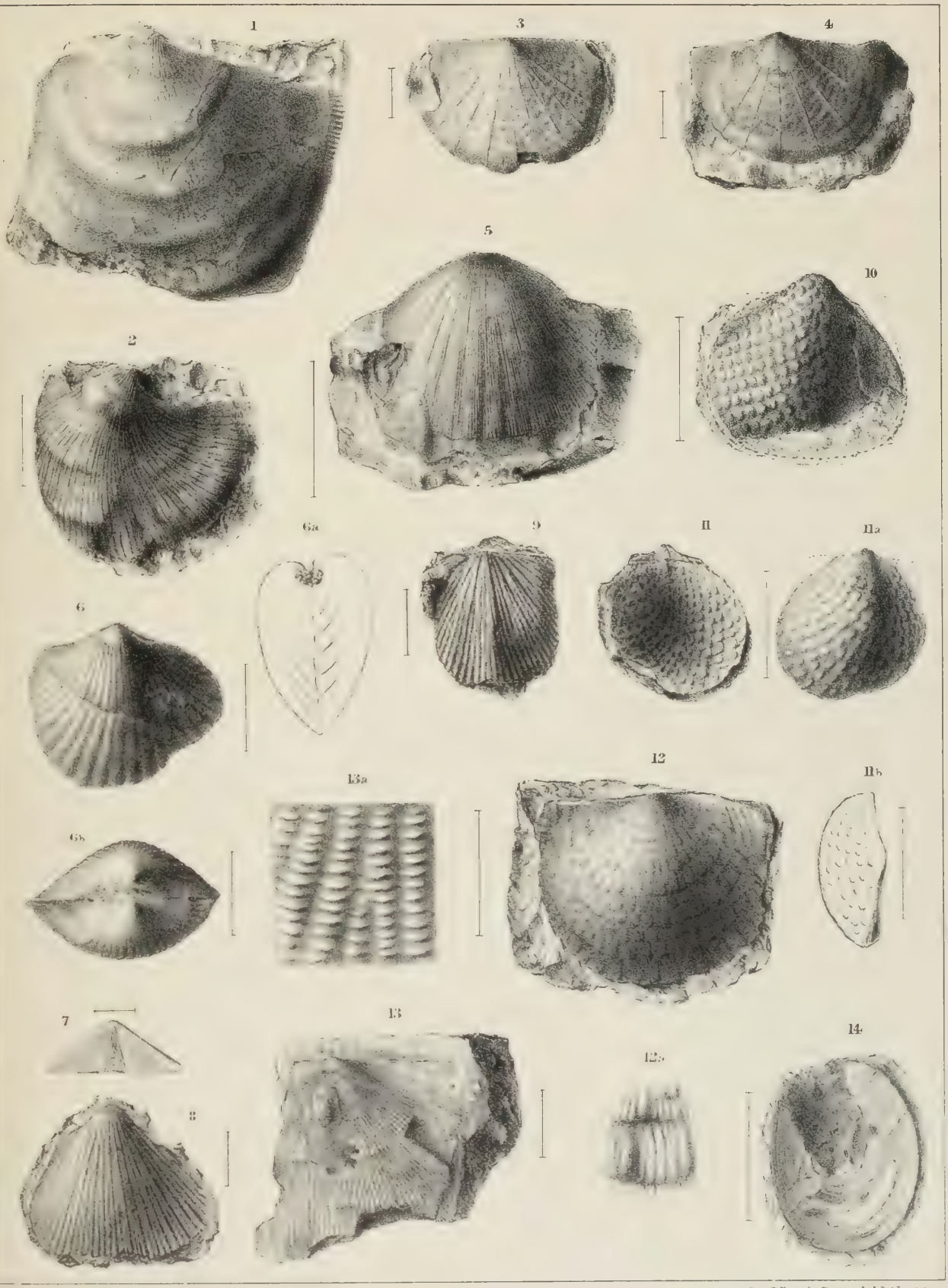
12. Ventral valve of a specimen showing the numerous elongate tubercles and the regular lines of growth, enlarged. 12 *a*, portions of surface magnified, showing the finer radiations.

CHONETIS HARDRENSIS, *Phillips*, sp. ? (Page 157.)

13. Dorsal valve of a defective specimen, much enlarged, showing the numerous divaricated rays. 13 *a*, portion of surface, showing the transverse beading, × 20.

DISCINA PELTASTES, n. sp. (Page 159.)

14. Ventral valve, enlarged, seen from within, slightly dislocated by crushing, showing a minute tube which is accidentally fractured above, and whose foramen below is concealed by pressure ; showing also an anterior callosity and the surface-ornament.



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